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CONTENTS OF VOLUME 58

JANUARY 1949. NUMBER 1

	PAGE
Surgical Approach to Cancer. John J. Morton, M.D., Rochester, N. Y.....	1
Role of Splenectomy in Thrombopenic Purpura. George Bogardus, M.D.; Garrott Allen, M.D.; Leon O. Jacobson, M.D., and Charles L. Spurr, M.D., Chicago	16
Multiple Arterial Emboli: Three Successful Embolectomies in a Case of Bacterial Endocarditis. H. William Scott Jr., M.D., and J. Maxwell Williams Jr., M.D., Baltimore.....	28
Ligation of Carotid Arteries for Advanced Malignant Neoplasms of the Head and Neck. Allison J. Vosseler, M.D., and Bernard J. Ficarra, M.D., Brooklyn	35
Use of Barrel Stave Grafts in Spinal Fusion. H. R. McCarroll, M.D., and Richard Odell, M.D., St. Louis.....	42
Histologic and Chemical Aspects of Thrombus Formation. Ernst Friedlander, M.D., San Jose, Calif.....	48
A Colostomy Bag: New, Single Use, Disposable Bag with Individually Molded Collar. Adolph M. Brown, M.D., Chicago.....	54
Surgical Clinics:	
Complications of Injection of Thorotrast in the Carotid Artery. Depart- ment of Surgery, George Washington University School of Medicine, Washington, D. C.....	60
Orthopedic Surgery in the Army Air Forces During World War II:	
III. Psychologic Problems, Convalescent Care and Rehabilitation. J. Vernon Luck, M.D., Los Angeles; Hugh M. A. Smith, M.D., Memphis, Tenn.; Henry B. Lacey, M.D., Columbus, Ohio, and A. R. Shands Jr., M.D., Wilmington, Del.....	75
Progress in Orthopedic Surgery for 1946. A Review Prepared by an Editorial Board of the American Academy of Orthopaedic Surgeons:	
VI. Conditions Involving the Hip Joint. John J. Fahey, M.D., Chicago	89
VII. Conditions Involving the Shoulder, Neck and Jaw. David Bosworth, M.D., New York.....	97
VIII. Congenital Deformities. J. H. Kite, M.D., Atlanta, Ga.....	107

FEBRUARY 1949. NUMBER 2

Volvulus of the Cecum, with a Review of One Hundred Cases in the Literature and a Report of Six New Cases. J. L. Donhauser, M.D., and S. Atwell, M.D., Albany, N. Y.....	129
Situs Inversus with Associated Abnormalities: Review of the Literature and Report of Three Cases. J. Robert Johnson, M.D., Chicago.....	149
Effect of Heparin and Penicillin on Experimentally Produced Thrombophlebitis. Jacob Rabinovitch, M.D., and Bernard Pines, M.D., Brooklyn.....	163
Factors Contributing to Low Mortality from Appendectomy for Acute Appendi- citis: A Ten Year Study. Arthur B. McGraw, M.D., Detroit.....	171
Unfavorable Reactions to Oxidized Cellulose (Oxycel) in the Bed of the Gallbladder: The "Retained Oxycel Sponge Syndrome." Edward S. Vanderhoof, M.D., and K. Alvin Merendino, M.D., Minneapolis.....	182

FEBRUARY—*Continued*

	PAGE
Progress in Orthopedic Surgery for 1946. A Review Prepared by an Editorial Board of the American Academy of Orthopaedic Surgeons:	
IX. Infections of the Bones and Joints. Prepared by Philip Lewin, M.D., Chicago	189
X. Congenital Dislocation of the Hip. A. Bruce Gill, M.D., Philadelphia	236

MARCH 1949. NUMBER 3

Surgical Treatment of Ulcerative Colitis. Garnet W. Ault, M.D., Washington, D. C.....	243
Degenerative Osteoarthritis of the Hip Joint: Survey of Degenerative Arthritis Secondary to Aseptic Necrosis of the Femoral Head. Thomas Horwitz, M.D., Indianapolis	251
Present Status of the Injection Treatment of Hernia. Amos R. Koontz, M.D., Baltimore	273
Treatment of Perforation of Gastrojejunal Ulcer by Resection of Stomach and Anastomosis. Alexander Lurje, M.D., Moscow, Union of Soviet Socialist Republics	281
Use of Human Fibrin Foam and Thrombin Solution as Hemostatic Agents in General Surgery. David State, M.D., Minneapolis.....	284
Follow-Up Results of Surgical Treatment for Nonunion of the Carpal Scaphoid Bone: Report of Nineteen Cases. C. Fred Goeringer, M.D., Philadelphia. .	291
Reaction in Surgical Wounds to Surgical Gut, Silk and Cotton Sutures. Morton D. Pareira, M.D., St. Louis.....	308
Extent of Strangulation of the Small Intestine Compatible with Life: Experimental Study. J. Gaster, M.D.; H. A. Davis, M.D.; P. A. Pritel, M.D., and R. L. Marsh, M.D., Los Angeles.....	312
Osteoid Osteoma: Report of a Case with Probable Double Lesion. Paul W. Lapidus, M.D., and Edward P. Salem, M.D., New York.....	318
Surgical Clinics:	
Cystic Emphysema of the Lungs. W. Emory Burnett, M.D., and Staff, of the Temple University Medical School, Philadelphia.....	328
Progress in Orthopedic Surgery for 1946. A Review Prepared by an Editorial Board of the American Academy of Orthopaedic Surgeons:	
XI. Conditions Involving the Lower Part of the Back. R. Beverly Raney, M.D., Durham, N. C.....	352
XII. Conditions Involving the Elbow, the Forearm, the Wrist and the Hand. Walter C. Graham, M.D., Santa Barbara, Calif.....	372
XIII. Amputations, Apparatus and Technic. J. Warren White, M.D., Greenville, S. C.....	399

APRIL 1949. NUMBER 4

Hiatus Hernia. G. G. Richards, M.D., and K. A. Crockett, M.D., Salt Lake City	411
Incidence of Hiatus Hernia and Associated Lesions Diagnosed by Roentgen Ray. Irving B. Brick, M.D., Washington, D. C.....	419
Differential Diagnosis of Hiatus Hernia and Coronary Artery Disease. Arthur M. Master, M.D.; Simon Dack, M.D.; Jacob Stone, M.D., and Arthur Grishman, M.D., New York.....	428
Granular Cell Myoblastoma of the Anterior Rectus Sheath. Seymour S. Rogers, M.D., Greensboro, N. C.....	450

, APRIL—Continued

	PAGE
Treatment of Peptic Ulceration by Vascular Ligation. W. Quarry Wood, Ch.M., F.R.C.S.E., Edinburgh, Scotland.....	455
Aspiration of Blood from Pericardium in Treatment of Acute Cardiac Tamponade After Injury: Further Experience, with Report of Cases. Mark M. Ravitch, M.D., and Alfred Blalock, M.D., Baltimore.....	463
Tetanus Treated as a Respiratory Problem. Vernon C. Turner, M.D., and Thomas C. Galloway, M.D., Evanston, Ill.....	478
Acute Pancreatitis and Its Sequelae. Thomas J. Anglem, M.D., and William F. Lee Jr., M.D., Brookline, Mass.....	484
Pathogenesis of Postoperative Pulmonary Atelectasis: An Experimental Study. Randolph T. Shields Jr., M.D., Black Mountain, N. C.....	489
Nonsuture Method for Vascular Anastomosis Utilizing the Murphy Button Principle. Harry H. LeVeon, M.D., New York.....	504
Lymphosarcoma of the Duodenum: Report of a Case; Review of the Literature. Murray M. Copeland, M.D., Washington, D. C., and D. James Greiner, M.D., Memphis, Tenn.....	511
Benign Nonepithelial Tumors of the Stomach. Jacob Rabinovitch, M.D.; David Grayzel, Ph.D., M.D.; Alfred J. Swyer, M.D., and Bernard Pines, M.D., Brooklyn	529
Surgical Forum. Robert Elman, M.D., St. Louis.....	539
Progress in Orthopedic Surgery for 1946. A Review Prepared by an Editorial Board of the American Academy of Orthopaedic Surgeons:	
XIV. Diseases of Growing and Adult Bone. John A. Siegling, M.D., Charleston, S. C.....	541
XV. Tuberculosis of Bones and Joints. Alan DeForest Smith, M.D., New York	546
XVI. Infantile Paralysis. C. E. Irwin, M.D., Warm Springs, Ga.....	561

MAY 1949. NUMBER 5

More Human Attitudes in Surgical Practice: Presidential Address. Harry B. Zimmermann, M.D., St. Paul.....	565
Revascularization Following Experimental Mesenteric Vascular Occlusion. Rudolf J. Noer, M.D., and John William Derr, M.D., Detroit.....	576
Use of Portacaval Anastomosis in Portal Cirrhosis. A. C. Pattison, M.D., Pasadena, Calif.	590
Use of Heparin and Dicumarol in the Active Treatment of Thromboembolism. John H. Olwin, M.D., Chicago.....	603
Diagnosis and Surgical Treatment of Patent Ductus Arteriosus. Willis J. Potts, M.D.; Stanley Gibson, M.D.; Sidney Smith, M.D., and William L. Riker, M.D., Chicago.....	612
Repair of Defects in Ethmoid and Frontal Sinuses Resulting in Cerebrospinal Rhinorrhea. Alfred W. Adson, M.D., and Alfred Uihlein, M.D., Rochester, Minn.	623
Pseudohemophilia or Chronic Thrombasthenia. Charles W. McLaughlin Jr., M.D., Omaha	635
Surgical Treatment of Benign and Secondarily Malignant Tumors of the Esophagus. Stuart W. Harrington, M.D., Rochester, Minn.....	646
Surgical Treatment of Carcinoma of the Esophagus and Stomach. Harold Lincoln Thompson, M.D., Ph.D., Los Angeles.....	662
Discussion: Anesthesia in Transthoracic Surgery of the Alimentary Tract. Harry Brown, M.D., Los Angeles.....	679

MAY—Continued

	PAGE
Treatment of Jejunal Ulcer: A Comparative Follow-Up Study. Henry K. Ransom, M.D., Ann Arbor, Mich.....	684
Repeated Massive Intestinal Hemorrhage from Multiple Malignant Tumors of the Jejunum. Orville R. Clark, M.D., and William M. Mills, M.D., Topeka, Kan.	701
Polyposis of the Colon. E. Lee Strohl, M.D., and Guy V. Pontius, M.D., Chicago	708
Situs Inversus Totalis: A Statistical Review of Data on Seventy-Six Cases with Special Reference to Disease of the Biliary Tract. Charles W. Mayo, M.D., and Roberta G. Rice, M.D., Rochester, Minn.....	724

JUNE 1949. NUMBER 6

Prefrontal Lobotomy in the Management of Intractable Pain. Colonel Frank E. Hamilton and Major George J. Hayes, Medical Corps, United States Army	731
Surgical Management of Instrumental Perforation of the Esophagus. J. Dewey Bisgard, M.D., and H. Harper Kerr, M.D., Omaha.....	739
Hemihepatectomy with Hepaticojejunostomy for Irreparable Defects of the Bile Ducts. R. L. Sanders, M.D., Memphis, Tenn.....	752
Gastrojejuno-colic Fistula. Stanley E. Lawton, M.D., and Arthur R. Marks, M.D., Chicago	762
Phlegmonous Cecitis: Report of Two Cases. W. L. Riker, M.D.; R. K. Gilchrist, M.D., and V. C. David, M.D., Chicago.....	772
Hidden Carcinoma of the Breast. Howard D. Cogswell, M.D., Tucson, Ariz..	780
Effects on the Breast of Removal of the Nipple or Severing of the Ducts. Herbert H. Davis, M.D., Omaha.....	790
Mediastinal Tumors. A. R. Curreri, M.D., and J. W. Gale, M.D., Madison, Wis.	797
Suppurative Disease of the Lungs. Fred R. Harper, M.D.; William B. Condon, M.D., and William H. Wierman, M.D., Denver.....	819
Hernia into the Umbilical Cord and Omphalocele (Amniocoele) in the Newborn. Clifford D. Benson, M.D.; Grover C. Pemberthy, M.D., and Edward J. Hill, M.D., Detroit.....	833
Thumb Traction Technic for Reduction of Colles' Fracture. Ralph G. Carothers, M.D., Cincinnati, and Foster J. Boyd, M.D., Indianapolis.....	848
Classification and Treatment of Trochanteric Fractures. Harold B. Boyd, M.D., Memphis, Tenn., and Lawrence L. Griffin, M.D., Austin, Texas....	853
Hemipelvectomy for Malignant Tumors of the Bony Pelvis and Upper Part of the Thigh. Robert A. Wise, M.D., Portland, Ore.....	867
Carcinoma of the Thyroid Gland. Arnold S. Jackson, M.D., Madison, Wis....	875
The Elderly Patient as a Surgical Risk: An Analysis of Three Hundred and Twenty-Two Operations Performed on Two Hundred and Forty-Four Patients Sixty Years of Age and Over. Willard H. Parsons, M.D., and W. K. Purks, M.D., Vicksburg, Miss.....	888
Congenital Anorectal Atresia: Report of a Case. Robert J. Patton, M.D., Springfield, Ill.	907
General Index	913

SURGICAL APPROACH TO CANCER

JOHN J. MORTON, M.D.

ROCHESTER, N. Y.

UNTIL better methods of treatment become available surgical intervention has and will have a definite place in the therapy of cancer. The theory on which the surgical approach is based is that cancer is a lethal condition. When it once starts, the course is steadily progressive. Reversal of the growth and spontaneous cure is almost unknown, occurring in 1 of 100,000 cases according to Bashford, cited by Rae.¹ The rapidity of the process is conditioned by the age of the patient, the degree of differentiation of the cells, the hormone balance and other factors. In some instances the growth may be greatly retarded or even contained locally for considerable periods. But these instances are exceptional and not to be expected.

Surgical therapy should be based on accurate diagnosis because the surgical treatment of malignant growths is radical in type. Consequently few surgeons would feel on safe grounds if the complete radical resections were to be done on the basis of clinical symptoms and signs alone. For this reason some form of biopsy becomes essential, with expert interpretation of the type of tissue and its possibilities.

All the evidence that exists is that cancer in the early stages is a local disease and not the local manifestation of a generalized process. The leukemias may be considered an exception to this since the malignant cells arise in close contact with the blood stream and are generalized by the time they are recognized. In some cases of lymphosarcoma, plasma cell myeloma and Hodgkin's disease the condition seems to be widespread from the beginning. In others the condition appears locally at first and disseminates rather quickly at a later date.²

From the Department of Surgery, University of Rochester School of Medicine and Dentistry.

This address was presented at the Fourth International Cancer Research Congress, St. Louis, Sept. 3, 1947.

1. (a) Rae, M. V.: Spontaneous Regression of a Hypernephroma, *Am. J. Cancer* **24**:839-841, 1935. (b) Rohdenburg, G. L.: Fluctuations in the Growth Energy of Malignant Tumors in Man, with Especial Reference to Spontaneous Regression, *J. Cancer Research* **3**:193-225, 1918. (c) Shore, B. R.: Spontaneous Cure of a Congenital Recurring Connective Tissue Tumor, *Am. J. Cancer* **27**:736-739, 1936.

2. (a) Craver, L. F.: Five Year Survivals in Hodgkin's Disease, *Am. J. M. Sc.* **188**:609-612, 1934. (b) Craver, L. F., in Pack, G. T., and Livingston,

(Footnote continued on next page)

The current theory is that most of these types arise in multiple centers. If all cancers could be recognized while still in the local phase, thorough removal would be curative. The surgeon in such happy circumstances would still face a dilemma because he could not be certain in any way at present whether the cancer had spread to the regional lymph nodes or through the blood stream. If he performed a local removal only, he would have to watch his patient carefully for several years to determine whether there had been spread of the cancer or not.

The surgeon must be familiar with the methods of spread of cancer. He must be acquainted with the natural history and the biologic aspects of the many kinds of cancer to which the body may be heir. In general, the methods of spread are the following: lymphatic embolism²; perineural lymphatic infiltration⁴; lymphatic permeation⁵; blood vessel embolism; invasion through and between neighboring tissues, and travel across serous cavities. It has been difficult to account for metastatic lesions of the brain from tumors of the lung and of the abdominal viscera. It would seem that the capillary beds of the lung and liver would filter out the cells and not allow them to pass cephalad. It has been demonstrated that these metastases take place via the spinal veins which have no valves. On forced inspiration, coughing or retching, the cells are forced into these open venous channels and gain ready access to the cerebral circulation.⁶ The lymphatic vessels, in a general way, accompany the blood vessels. The lymph nodes are scattered near the junction points of the branches and tributaries. When the lymphatic vessels are invaded, those nearest the original focus naturally are most likely to receive the metastasis. These regional nodes become involved before there is a generalized spread. This forms the basis for the surgical practice of removal en bloc, in which the primary cancer and its regional nodes are taken in one block of

E. M.: *Treatment of Cancer and Allied Diseases*, New York. Paul B. Hoeber, Inc., 1940, vol. 3, p. 2488. (c) Gall, E. A.: *The Surgical Treatment of Malignant Lymphoma*, *Ann. Surg.* **118**:1064-1070, 1943. (d) McSwain, B., and Beal, J. M.: *Lymphosarcoma of the Gastro-Intestinal Tract*, *ibid.* **119**:108-123, 1944. (e) Pasternack, J. G., and Waugh, R. L.: *Solitary Myeloma of Bone*, *ibid.* **110**:427-436, 1939. (f) Taylor, E. S.: *Primary Lymphosarcoma of the Stomach*, *ibid.* **110**:200-221, 1939.

3. Gilchrist, R. K.: *Fundamental Factors Governing Lymphatic Spread of Carcinoma*, *Ann. Surg.* **111**: 630-639, 1940.

4. Fraser, J.: *Carcinoma of the Floor of the Mouth and Tongue*, *Ann. Surg.* **96**:488-514, 1932. Warren, S.; Harris, P. N., and Graves, R. C.: *Osseous Metastasis of Carcinoma of the Prostate with Special Reference to Perineural Lymphosarcoma of the Gastro-Intestinal Tract*, *ibid.* **119**:108-123, 1944. (e)

5. Handley, W. S.: *Cancer of the Breast and Its Treatment*, New York. Paul B. Hoeber, 1922.

6. Batson, O. V.: *The Function of the Vertebral Veins and Their Role in the Spread of Metastases*, *Ann. Surg.* **112**:138-149, 1940.

tissue. None of the intervening tissues can be spared but must be sacrificed without hesitation so that no cancer cells will be spilled in the dissection. When the surgeon can remove the cancer and its regional nodes before the disease has progressed beyond the limits of his operation, the patient will be cured.

Block dissection can be applied in cancers of the breast, cancers of the colon and rectum, cancers of the small intestine,⁷ cancers of the peripheral parts of the lung, cancers of the thyroid (unilaterally),⁸ and, in some instances, in squamous cell carcinomas of the skin and in melanoma malignum.⁹ In carcinoma of the gastric antrum an almost complete block dissection is possible. In lesions higher in the stomach the lymphatic drainage is more extensive, and it is difficult to eradicate in one block of tissue. In some cases of lymphosarcoma and Hodgkin's disease radical resection of the involved nodes and of the rest of the chain en bloc has been successful.^{2a, b}

Wide primary lateral resections formerly advocated for the carcinomatous lesions of the lips and oral cavity have been abandoned. These radical operations carried a threat to life by opening large areas to infection. It also had been found that this group formed an exception to the rule of block dissection. The intervening tissues between the primary growth and the first lymph nodes rarely showed secondary implants so that such areas could be left behind without the chance for cure being jeopardized. The original intraoral lesions, except for the smaller growths, proved more difficult to eradicate because of anatomic reasons. Surgeons began to leave the outlying nodes until the primary lesion could be brought under control. If the primary lesion could not be eradicated or if it recurred quickly, it was useless to subject the patient to dissection of the glands of the neck. Furthermore, the metastatic trends were not predictable in many cases. As a general rule, in most instances the suprahyoid nodes proved to be the first line of defense, and the deep nodes of the jugular areas were only later developments. The arguments for and against prophylactic dissection of the lymph nodes have waxed and waned according to the convictions of those concerned.¹⁰ The difficulty is that metastasis to

7. Cameron, A. L.: Primary Malignancy of the Jejunum and Ileum, *Ann. Surg.* **108**:203-220, 1938.

8. (a) Crile, G., and Crile, G., Jr.: A Radical Operation for Malignant Tumors of the Thyroid Gland, *Surg., Gynec. & Obst.* **64**:921-934, 1937. (b) Lahey, F. H.; Hare, H. F., and Warren, S.: Carcinoma of the Thyroid, *Ann. Surg.* **112**:977-1005, 1940.

9. deCholnoky, T.: Malignant Melanoma, *Ann. Surg.* **113**:392-410, 1941.

10. (a) Brown, J. B., and McDowell, F.: Treatment of Metastatic Carcinoma of the Neck, *Ann. Surg.* **119**:543-555, 1944. (b) Kennedy, R. H.: The Management of Lymph Nodes in the Neck Metastatic from Carcinoma of the Mouth,

lymph nodes cannot be determined clinically by the methods of physical examination. When the nodes are not palpable or even suspected, there may be a 10 per cent involvement. When the nodes are palpable, the error in the assessment of metastasis runs between 25 and 30 per cent.¹¹ The mistakes in the latter instance are in both directions, i. e., the examiner thinks that there is involvement and microscopic section fails to show it or vice versa. The old argument was that no chances should be taken but that a prophylactic dissection should be done in every instance. In regard to the nonpalpable nodes such dissection was unnecessary in 9 of 10 cases. On the other hand, when nodes are palpable it is difficult for the surgeon to withhold operation because the chance for error is great. Even when the nodes are involved there is a good five year result in over 50 per cent of cases.

Thus there has arisen gradually another surgical principle for the treatment of cancers of certain regions. First, eradicate the original growth and then remove the regional nodes at a later date, prophylactically in instances in which the malignancy is of a high degree and metastasis is known to be likely and in other cases only after the patient has been closely observed at stated intervals until involvement of the nodes becomes evident. In this way unnecessary dissection of lymph nodes may be avoided.

Cancers which may be treated by this method are squamous cell cancers of the lips, buccal mucosa, gingivae and hard palate and certain squamous cell cancers of the skin. When such primary lesions of the skin are small and of well differentiated nature histologically and when no nodes are palpable, prophylactic dissection may be omitted, especially in cancers of the fingers, hands and trunk and in those of the face, eyelids, nose, scalp, neck and ears. In all these dissection of lymph nodes is optional unless the lesions are large, undifferentiated histologically, recurrent from previous treatment and accompanied with sizable palpable nodes. If they are of this nature, the primary lesion must first be controlled and dissection of the nodes done at a second operation. The local early cure seems to prevent metastasis in a majority of these types of lesions.

ibid. **114**:813-819, 1941. (c) Martin, H.: The Treatment of Cervical Metastatic Cancer, ibid. **114**:972-985, 1941. (d) Martin, H.; MacComb, W. S., and Blady, J. V.: Cancer of the Lip, ibid. **114**:226-242 and 341-368, 1941. (e) Taylor, G. W., and Nathanson, I. T.: Lymph Node Metastasis, New York, Oxford University Press, 1942, p. 168; (f) Evaluation of Neck Dissection in Carcinoma of the Lip, Surg., Gynec. & Obst. **69**:484-492, 1939. (g) Taylor, G. W.; Nathanson, I. T., and Shaw, D. T.: Epidermoid Carcinoma of the Extremities with Reference to Lymph Node Involvement, Ann. Surg. **113**:268-275, 1941.

11. Harrington, S. W.: Unilateral Carcinoma of the Breast Treated by Surgical Operation and Radiation, Surg., Gynec. & Obst. **60**:499-504, 1935. Taylor and Nathanson.^{10e}

In squamous cell cancers of the skin of the feet, legs or arms and in malignant melanomas, except for those on the trunk, prophylactic dissection of lymph nodes is better done after the primary lesion has been removed. These lesions are so prone to metastasize that unnecessary chances are taken if the nodes are not removed. Suprahyoid dissection bilaterally is advisable also for carcinomas of the antrum, floor of the mouth, soft palate and anterior part of the tongue after the primary lesion has been erased. In cancers of the anus, vulva, vagina, scrotum and penis the patient should be carefully watched every month for evidence of lymph node invasion after the primary lesion is controlled. Bilateral dissection of the groin may be necessary to control the spread if the condition of the patient is good enough to withstand such an ordeal. In malignant melanomas of the trunk there is a possibility of metastasis upward toward the axilla or downward toward the groin, and often it is impossible to gage their spread. Lymphoepitheliomas and transitional cell cancers will require dissection of the lymph nodes usually.

Whenever dissection of lymph nodes is omitted, the surgeon takes on a grave responsibility. He must arrange for a periodic follow-up and examine the regional nodes for evidence of trouble. He must not allow his patient to miss an appointment. This means a date file and a follow-up if the patient fails to appear. The social service workers have a special field of usefulness in this type of endeavor. The frequency of examination is determined by the type of histologic changes, the age of the patient and numerous other factors. After that it becomes a matter of responsibility and thoroughness in order to detect metastasis at the earliest possible moment.

A third type of surgical handling has evolved through clinical experience. Cancers of some types have a low grade of malignancy. Local removal is all that is required in such growths because the likelihood of metastasis is remote. Such cancers of the skin as the basal cell group rarely extend to the lymph nodes. Thorough local removal will cure them. Mixed tumors of salivary glands affecting the parotid, intra-oral and cervical regions have a low index of malignancy. Their growth is slow, and recurrence is rare after proper careful removal. The majority of the recurrences, in my opinion, reflect inadequate surgical treatment and a failure to recognize the "collar button" extensions.¹² Many of these parotid tumors which do recur are malignant cancers in the beginning and call for more radical removal at that time. Adamantinomas are a similar group of slowly growing tumors which do not

12. (a) Bailey, H.: The Treatment of Tumours of the Parotid Gland, *Brit. J. Surg.* **28**:337-346, 1941. (b) Houck, J. W.: Tumors of the Salivary Glands, *Surgery* **6**:550-584, 1939. (c) Montanus, W. P.: Mixed Tumor of the Parotid Gland with Metastasis, *ibid.* **4**:423-429, 1938.

recur if removed intact either in their capsules or by resection of the involved bone. Recurrences are slow, and lesions may be removed locally again, with a wider margin. Intrinsic operable cancers of the larynx may be removed by a simple laryngofissure or by a narrow field incision confined to the midline according to the technic of Crowe and Broyles. When the laryngeal cancer becomes extrinsic, it is a different situation. Leiomyomas of the stomach are really benign tumors easily cured by local resection, as are also the gastric polyps and "polyps en nappe." The carcinoids or the argentaffin tumors are slow in their progress, and this includes those which have spread beyond the original focus (25 per cent). Three fourths of these lesions can be removed locally without danger of recurrence from the region of the appendix, cecum and terminal ileum; their bright yellow color helps the surgeon to decide on their nature.¹³ Cancer of the body of the uterus is cured by simple hysterectomy in a high percentage of cases. Practically all fibrosarcomas can be handled by simple resection which includes the fascia of the underlying muscle or by removal of the muscle from its origin to its insertion in the same block. This is because only about 5 per cent of them metastasize. They may recur locally several times, often giving the surgeon a number of opportunities to get rid of them. Neurosarcomas offer similar chances even though it is necessary to resect part of a bone to give them a good margin in removal. Meningiomas may be successfully handled by careful dissection even when the overlying bone is widely invaded. The bone flap in such instances can be sacrificed, as tantalum makes a fine substitute for it. Tumors of the peripheral nerves of the spinal cord are usually benign, the symptoms and signs being a result of their anatomic location. The same is true of the neurinomas of the eighth nerve, recurrence being avoided by the complete removal of the capsule.¹⁴ The astrocytomas can be successfully handled if the neurosurgeon recognizes the importance of removing the solid nodules from the wall of the cystic cavity. No recurrence will follow if this step is carefully done. The peculiar fluffy appearance of the calcification in ependymomas and oligodendrogliomas warns the surgeon that he must make a wide exposure. These tumors extend beyond the areas of calcification, and if ample exposure is made it is sometimes possible to excise them in toto by giving them a good margin.^{14a} The pearly tumors are benign dermoids and do not

13. Wyatt, T. E.: Argentaffine Tumors of the Gastro-Intestinal Tract, *Ann Surg.* **107**: 260-269, 1938.

14. Dandy, W. E.: Removal of Cerebellopontile (Acoustic) Tumors Through a Unilateral Approach, *Arch. Surg.* **29**: 337-344 (Sept.) 1934.

14a. Sachs, E.: Surgery of Brain Tumors Today and Ten Years Ago, *Surgery* **9**: 883-895, 1941.

recur after even partial removal. The surgeon counts himself most fortunate when he exposes this lesion. Finally, surgeons should know about "blue nevi," i. e., benign lesions of typical spindle cell type described by Jadassohn and Tietze.¹⁵ These lesions should be let alone or should be removed locally. The patient should be reassured and not alarmed regarding them.

There are some lesions which biologically call for drastic measures, but surgeons have preferred to try simpler approaches. Resections and amputations for some bone sarcomas of low grade malignancy such as chondrosarcomas, parosteal sarcomas, malignant giant cell tumors or osteogenic sarcomas of highly differentiated types have been done successfully by some surgeons.¹⁶ Bone grafts have been placed to restore the function of the limb.

The surgical approach to a fourth group of malignant lesions may be called that of "last chance" or "desperation" therapy. Cancers in some situations do not lend themselves to removal of the regional areas. This may be due to the presence in the area of important and essential blood channels such as the aorta, the portal vein and the superior mesenteric artery or of both ureters or the bronchi. Radiation therapy as a rule is unfavorable for the internal cancers. There being nothing left to do, the patient and surgeon may prefer to take a gamble that local removal or local and partial regional removal might possibly succeed. A certain number of the patients survive, and there is no recurrence or metastasis. This is a rather flimsy basis for procedure, but it does offer some hope and is preferable to condemning the patients to certain death without a chance for a fight. For instance, some tumors are notorious for their rapid general spread through the body by means of the blood stream, the lymphatic vessels or both. The hypernephromas are an example of lesions in which widespread metastasis to the pulmonary fields, the long bones, the scapula and the skull (often as pulsating tumors) and to bizarre locations such as the tip of the tongue (Strong Memorial Hospital case 210769), the axilla and the parotid region makes it exceedingly unlikely that the surgeon can offer any help. Yet in some cases simple nephrectomy has resulted in cure, and in others metastasis does not occur for many years after such an operation. In the latter it even seems worth while to remove the metastatic focus as it may represent the only tumor tissue remaining in the body.

15. Montgomery, H., and Kahler, J. E.: The Blue Nevus (Jadassohn-Tietze): Its Distinction from Ordinary Moles and Malignant Melanomas, *Am. J. Cancer* **36**:527-539, 1939.

16. Coley, B. L., and Pool, J. L.: Factors Influencing the Prognosis in Osteogenic Sarcoma, *Ann. Surg.* **112**:1114-1128, 1940. Phemister, D. B.: Conservative Surgery in the Treatment of Bone Tumors, *Surg., Gynec. & Obst.* **70**: 355-364, 1940.

A 58 year old man entered the hospital with a large tumor mass in the right femur (Strong Memorial Hospital case 212059). Sixteen years previously he had a hypernephroma removed with his right kidney. Amputation of the hip joint was done. The microscopic examination showed typical hypernephroma tissue in the femur. Four years later he was getting about well on an artificial limb, without evidence of metastatic tumor anywhere.

The Wilms tumor in babies is a similar unfavorable type which may be cured by simple nephrectomy.¹⁷ Life is saved in occasional cases of osteogenic sarcomas, Ewing's tumor of bone,¹⁸ chondrosarcoma^{12c} and synovial sarcoma¹⁹ by early amputation well above the lesions. Soma ovarian tumors with widespread peritoneal implants are cured by ovariectomy. Castration may be all that is necessary to rescue some patients with testicular tumors and even a rare one with prostatic carcinoma. Patients with tumors of the upper part of the thigh such as rhabdomyosarcomas, liposarcomas and tumors of the femur and those with tumors of the pelvic bones have been given a chance for life by the formidable hindquarter resection advocated by Gordon-Taylor.²⁰ Even lymphosarcomas may be removed successfully in the early stages before general spread has taken place.^{2a,b} The anatomic difficulties are almost insurmountable in the treatment of malignant growths in some locations. Primary cancer of the liver can rarely be removed because of the ducts and vessels involved. The central cancers of the lung are usually beyond surgical help. The mediastinal nodes are too scattered through the hilar regions to allow dissection. And yet surgeons have successfully removed cancers of the peripheral parts of the lung by lobectomy or preferably by unilateral pneumonectomy. The middle and lower parts of the esophagus posed the difficulty of restoration of the gastrointestinal tract if their relatively late metastasizing cancers were removed. Surgeons learned how to make this anastomosis successfully by approaching these tumors through the chest and by bringing the stomach up through the diaphragm as high as the aorta if neces-

17. Ladd, W. E.: Embryoma of the Kidney (Wilms's Tumor), *Ann. Surg.* **108**:885-902, 1938.

18. Morton, J. J.: The Treatment of Ewing's Sarcoma of Bone, in Pack, G. T., and Livingston, E. M.: *Treatment of Cancer and Allied Diseases*, New York, Paul B. Hoeber, Inc., 1940, vol. 3, pp. 2422-2436.

19. Briggs, C. D.: Malignant Tumors of Synovial Origin, *Ann. Surg.* **115**: 413-426, 1942. Moretz, W. H.: Malignant Tumors Arising from the Synovial Membrane with Report of Four Cases, *Surg., Gynec. & Obst.* **79**:124-132, 1944.

20. Gordon-Taylor, G.: Further Review of Interinnomino-Abdominal (Hind Quarter) Amputation: Eleven Personal Cases, *Brit. J. Surg.* **27**:643-650, 1940. Morton, J. J.: Interinnomino-Abdominal (Hindquarter) Amputation, *Ann. Surg.* **115**:628-646, 1942.

sary.²¹ Most cancers of the stomach are too advanced to be successfully removed surgically in spite of the extension of the operation to include total gastrectomy.²² Cancers of the gallbladder have inaccessible nodes, and it is pure chance when one is successfully removed.²³ Cancers of the ampulla, the duodenum and the head and body of the pancreas have been removed by the approach practiced by Whipple and others²⁴ when once it was found that the pancreas could be resected or removed in toto if necessary. In these operations there are many technical problems in restoration of the ducts and of the gastrointestinal tract. The portal vein and the wide lymphatic drainage add to the difficulties in securing good results.²⁵ Cancers of the cervix were for a period treated surgically when the Wertheim operation was in its heyday.²⁶ It was considered too difficult a dissection, and radiation treatment gradually took the lead until recently. Now the Wertheim operation is being revived.²⁷ It fails as a complete block dissection because of the ureters. It is there that difficulties in the operation keep it from being ideal. Some cancers of the bladder can be removed only after both ureters have been transplanted into the sigmoid. By these maneuvers it has been possible to save some patients with this lesion.²⁸ The radical resection of prostatic cancer according to Young's operation is useful and promising when the cancer has not invaded the capsule and become fixed.²⁹ Castra-

21. Churchill, E. D., and Sweet, R. H.: Transthoracic Resection of Tumors of the Stomach and Esophagus, *Ann. Surg.* **115**:897-920, 1942. Clark, D. E.: Transthoracic Esophagogastronomy for Carcinoma of the Middle Third of the Esophagus, *ibid.* **121**:65-73, 1945. Garlock, J. H.: The Surgical Treatment of Carcinoma of the Thoracic Esophagus, *Surg., Gynec. & Obst.* **66**:534-548, 1938.

22. Graham, R. R.: A Technique for Total Gastrectomy, *Surgery* **8**:257-264, 1940. Lahey, F. H., and Marshall, S. F.: Indications for and Experience with Total Gastrectomy, *Ann. Surg.* **119**:300-320, 1944. Ogilvie, W. H.: Cancer of the Stomach, *Surg., Gynec. & Obst.* **68**:295-305, 1939. Parsons, L., and Welch, C. E.: The Curability of Carcinoma of the Stomach, *Surgery* **6**:327-338, 1939.

23. Lam, C. R.: The Present Status of Carcinoma of the Gallbladder, *Ann. Surg.* **111**:403-410, 1940. Lichenstein, G. M., and Tannenbaum, W.: Carcinoma of the Gallbladder, *ibid.* **111**:411-415, 1940.

24. Whipple, A. O.; Parsons, W. B., and Mullins, C. R.: Treatment of Carcinoma of the Ampulla of Vater, *Ann. Surg.* **102**:763-779, 1935.

25. Whipple, A. O.: The Rationale of Radical Surgery for Cancer of the Pancreas and Ampullary Region, *Ann. Surg.* **114**:612-615, 1941.

26. Bonney, V.: Treatment of Carcinoma of Cervix by Wertheim's Operation, *Am. J. Obst.* **30**:815-830, 1935. Taussig, F. J.: Iliac Lymphadenectomy with Irradiation in the Treatment of Cancer of the Cervix, *Am. J. Obst. & Gynec.* **28**:650-667, 1934.

27. Meigs, J. V.: Carcinoma of the Cervix: The Wertheim Operation, *Surg., Gynec. & Obst.* **78**:195-199, 1944.

28. Hinman, F., and Smith, D.: Total Cystectomy for Cancer, *Surgery* **6**:851-881, 1939.

29. Colston, J. A. C.: Carcinoma of the Prostate, *J. A. M. A.* **134**:848-852 (July 17) 1947.

tion is an alternative method of treatment of cancers of the prostate.³⁰ Carcinomas of the adrenal cortex may be slow to recur after simple adrenalectomy or a few may be cured. The neuroblastomas of children have never been treated successfully by surgical intervention as their spread is too rapid either through the lymph nodes to the mediastinum, pharynx, orbits and skull or into the liver. Ovarian tumors are unpredictable, but they are usually of such a high grade of malignancy that end results are unfavorable. Many patients with tumors handled partially by surgical intervention can be treated fairly successfully by supplementation with radiation therapy. A discussion of this would constitute a chapter in itself.

There is an additional group for which "last chance" surgical treatment is given, namely, those basal cell cancers which have invaded the antrum or orbit and which do not respond to radiation therapy. A wide destructive operation, in which the antrum is unroofed and the eye removed, may lead to cure. The patient must be watched for recurrences for a period, and plastic repair will then be necessary later. Skin will have to be brought in from an area not exposed to radiation as the viability of irradiated skin is notoriously uncertain.

The principle of prevention of cancer can be applied through surgical removal of lesions which are likely to become cancerous. The adenomas of the thyroid³¹ and the lateral aberrant thyroid nodules³² have been considered precancerous lesions for many years. Their removal is relatively easy in the benign state. Polyps of the colon and rectum are frequent precursors of carcinomas. Removal of these benign lesions is good preventive medicine and should be encouraged. Wangersteen has discovered and removed a number of polypoid lesions in the stomach by routine investigation of persons with anacidity. The papillary cyst-adenoma of the breast is a lesion which is hyperplastic and frequently difficult to evaluate. Keratoses of the skin of the face and hands and similar lesions due to arsenic and to roentgen ray exposure should be removed before they progress to malignancy. The same treatment should be advocated for many benign melanomas, sebaceous cysts, Bowen's disease and extramammary Paget's disease. Long-standing or repeatedly recurring ulcerations in scars and burns due to ischemic necrosis should be excised and skin grafted before malignant degeneration takes place. Papillomas of the lips and tongue and raised thickened patches of leukoplakia demand surgical attention before malignancy supervenes. Polyps of the nasal passages, papillomas of the larynx and ulcerations about

30. Huggins, C.: Prostatic Cancer Treated by Orchidectomy: The Five Year Results, *J. A. M. A.* **131**:576-581 (June 15) 1946.

31. Brenzier, A. G., and McKnight, R. B.: True Adenomas of the Thyroid Gland and Their Relation to Cancer, *Tr. Am. A. Study Goiter*, 1940, pp. 176-190.

32. Cattell, R. B.: Aberrant Thyroid, *J. A. M. A.* **97**:1761-1767 (Dec. 12) 1931.

the eustachian tube are better treated surgically as soon as possible. Adenomas of the bronchial tubes should be cared for.³³ Cysts and fistulas about the head and neck, especially those in the branchial cleft zones, must not be allowed to remain. Papillomas of the bladder, polyps of the uterus and caruncles of the urethra should be removed before they progress to an unfavorable degree. Epulides, many exostoses, chondromas and giant cell tumors of bone offer opportunities for preventive surgical therapy. Long-standing gallstones and stones in the kidneys and bladder could conceivably be chronic irritants which might set off the malignant reaction in the cells. Aberrant rests of heterotopic nature should be removed when encountered. Circumcision has been demonstrated as a practical preventive treatment against the future development of penile carcinoma.³⁴ Leukoplakia of the vulva is a dangerous lesion requiring surgical removal.³⁵

Another instance when surgical treatment may be used to advantage is when palliation is necessary. Surgeons have had to deal with advanced cancer for many years, and during that time they have been forced to learn how to add to the comfort of their patients. There are many ways in which operation can give relief. Obvious ulcerating lesions of the skin, parotid or breast can be excised even though metastasis has occurred. The area will heal, no dressing will be necessary and the infection will be controlled and the loss of serum and blood prevented. The same holds true for ulcerating carcinomas anywhere in the gastrointestinal tract. Formerly when metastasis was found at operation nothing was attempted with the primary growth. There has been a change of late to a more radical attitude, and now it is considered good surgical practice to remove these primary foci whenever possible without undue risk. For example, in rectal carcinoma an abdominal-perineal resection often provides a comfortable terminal existence though there is some metastasis to the liver. The postoperative course is much better, the irritating, seeping and infected areas are removed and the function of the bowel becomes normal again. In obstructing lesions palliative operations are useful when the growths are fixed and not resectable. Simple gastroenterostomy, enterostomy, enterocolostomy or colocolostomy all give comfort by relieving crampy pains, distention, constipation, diarrhea and tenesmus. Internal anastomoses are preferable to external drainage whenever feasible. However, relief of jaundice by external drainage of the gallbladder or common duct in some circumstances is exceedingly useful as palliation or as a first stage to

33. Adams, W. E.; Sterner, P. E., and Bloch, R. G.: Malignant Adenoma of the Lung, *Surgery* **11**:503-526, 1942.

34. Kennaway, E. L., and Kennaway, N. M.: The Social Distribution of Cancer of the Scrotum and Cancer of the Penis, *Cancer Research* **6**:49-53, 1946.

35. Sparrow, T. D.: Leukoplakic Vulvitis, *Ann. Surg.* **112**: 87-99, 1940.

resection. Similarly, gastrostomy may save a patient from starvation, tracheotomy may relieve him from asphyxia and colostomy may rid him of frequency, dysuria and tenesmus. The handling of these artificial openings requires careful attention to details, but with proper training the disagreeable features can be minimized and even brought to habit regulation. It is a great satisfaction to bring relief to a patient even for a period of months, and sometimes it is surprising how long patients will live in comfort with known metastasis to the liver. I have known a patient with gastric carcinoma in such circumstances to survive in perfect comfort for five years after a posterior gastroenterostomy was done and a patient with carcinoma of the colon in whom a resection and end to end anastomosis was done in similar circumstances to survive for seven years. Finally, there is the possibility of surgical relief from pain. If the painful areas can be sharply localized, relief may be given by section of the proper cranial nerves or the posterior roots or by chordotomy. In some instances also there may be need for resection of the sympathetic nerves. The relief afforded in this way is often dramatic.

The most striking palliative relief is experienced when castration is used for advanced carcinomas of the prostate. Huggins proposed this measure, and there has been almost unanimous agreement as to its efficacy. Within twenty-four hours, with a few exceptions, pain disappeared. No further opiates were necessary. There was improvement in energy and well-being. Patients ate better and gained weight. Some who were bedridden recovered the use of their paralyzed limbs. The destructive areas in the bones filled in with new bone. Enlarged lymph nodes, presumably with cancer in them, receded and could no longer be felt. Metastatic nodules in the pulmonary fields got smaller and even disappeared from roentgenograms of the chest.³⁶ The nodules in the prostate smoothed down so that the gland seemed normal to palpation. Residual urine lessened in amount, and infection tended to clear up. This palliative effect varied in time; some patients even have remained well for several years.³⁷ The majority, however, had relapses and recurrence of symptoms after six months to two years. All told, however, this palliation is worth while for men whose life expectancy at the time is not too great. Castration has been used for carcinoma of the male breast, and here again the results are promising.³⁸ It has been known for years that bilateral oophorectomy has been followed by

36. Alyea, E. P., and Henderson, A. F.: Carcinoma of the Prostate, *J. A. M. A.* **120**:1099-1102 (Dec. 5) 1942.

37. Huggins, C., and Hodges, C. V.: Studies on Prostatic Cancer, *Cancer Research* **1**: 293-297, 1941. Huggins.³⁰

38. Farrow, J. H., and Adair, F. E.: Effect of Orchidectomy on Skeletal Metastases from Cancer of the Male Breast, *Science* **95**:654, 1942.

remarkable improvement in some cases of breast cancer in the premenopausal group. Temporary improvement may be expected in about one third of the patients with recurrent or inoperable cancer.³⁹ The results are similar to those obtained in prostatic cancer in that pain lessens, the patient feels remarkably better, the appetite improves, there is gain in weight and strength, the bone lesions heal and recurrent nodules disappear. Palliation for the headaches accompanying tumors of the brain has been possible through decompression operations or by tapping through burr holes over the dilated ventricles.

By trial and error and by careful observation surgeons have learned how to judge operability in cases of cancer. Rules for the younger surgeons are passed on by their predecessors and emphasized whenever opportunity presents. Resectability has been extended by daring operations in which portions of other organs have been included in the block of tissue, with repair or with restoration of the continuity. Thus lesions adherent to the bladder, the liver or the small or large bowel have been removed with success. This has become possible as surgeons have learned to be careful of hemostasis and gentle with their handling of tissue. The methods of restoring blood volume, combating infection, preventing shock and exercising care in the preoperative and postoperative periods have led to feats of surgery undreamed of in the past.⁴⁰

There are some rules of inoperability which still obtain and which surgeons would do well to heed. Cancer of the breast is considered inoperable when it is fixed to the chest wall, when it is massive, involving almost the whole breast with edematous tissues, when there are numbers of scattered skin nodules, when there are enlarged hard supraclavicular nodes, when there is swelling of the arm, when there is visceral or osseous metastasis and when it is an inflammatory carcinoma. In addition to this it is inoperable when the carcinoma develops during pregnancy or lactation, when there is ulceration of the skin and when there is fixation of the axillary lymph nodes to the skin or deep structures of the axilla proved to contain metastatic lesions by biopsy.

39. Nathanson, I. T.: The Relationship of Hormones to Diseases of the Breast, *Surgery* **1**:108-140, 1944.

40. Bowers, R. F.: Surgical Treatment of Malignant Lesions of the Sigmoid with Extensions, *Ann. Surg.* **115**:986-995, 1942. Brunschwig, A., and Morton, D. R.: Resection of Abdominal Carcinomas Involving the Liver and Spleen Secondly, *ibid.* **124**:746-754, 1946. Brunschwig, A.: Radical Resections of Advanced Intra-Abdominal Cancer, *ibid.* **122**:923-932, 1945. David, V. C., and Gilchrist, R. K.: Extension of the Border Line of Operability in Cancer of the Rectum, *ibid.* **115**:566-573, 1942. Lahey, F. H.: Total Gastrectomy, Splenectomy, Resection of the Left Lobe of the Liver, Omentumectomy and Colectomy upon One Patient in One Operation, *ibid.* **119**:222-224, 1944. Sugarbaker, E. D.: Coincident Removal of Additional Structures in Resections for Carcinoma of the Colon and Rectum, *ibid.* **123**:1036-1046, 1946.

Haagensen and Stout⁴¹ have never seen a permanent cure following operation in these circumstances. When primary cancers of the intra-oral or cutaneous regions cannot be cured by surgical intervention or by irradiation it is useless to dissect the regional lymph nodes draining such areas. These recurrent lesions will almost certainly metastasize by some channels even if the regional lymph nodes have been removed. Also when the nodes are fixed, when they invade the muscles and the great vessels, when there are extracapsular involvement and matting and when there is multiple and distant metastasis, the cancer is inoperable. Inaccessibility of involved nodes constitutes another situation in which operative removal is not curative. This may occur with the nodes of esophageal cancer, cancer of the lung, or gastric cancer, in which the chain is along the superior mesenteric vessels. Widespread dispersion of nodules throughout the peritoneal or pleural cavities must be added to this list. Growths fixed to the parietes or "frozen" in the pelvis in such a way that the surgeon cannot get around them into noninvolved tissues are hopeless as far as removal is concerned.

There are certain principles applicable to all surgery, and surgical treatment for cancer is no exception. First of all, the surgeon must be grounded in the reaction of tissues to injury, in asepsis and antisepsis, in the fundamentals of refined technic, in the preoperative and post-operative preparations necessary to avoid reactions, in the treatment of shock and of unexpected complications and in the use of the antibiotics. In other words, he should be a good general surgeon even though he may specialize in a limited field later. He must consider his patient and strive to return him to a condition of useful living. It is not too difficult under the present advantages to remove some cancers by extensive procedures, but if the patient then remains marred physiologically or a burden to his family the treatment has not been successful. The surgeon must learn that there are many things to be considered in addition to the mechanical removal of diseased tissue. The restoration of the organs as near to their proper functions as possible is a goal to be desired. An understanding of the many and varied pathologic types of cancer may help him to evaluate his chances of successful treatment and assist him in his prognosis. It is well for him to know that some forms of cancer are highly malignant while others are exceedingly slow in growth. He should not be so enthusiastic over his therapy that he becomes "one sided" and fails to recognize that in some cases radiation therapy is as desirable as surgical intervention or better. When he has decided on operation, it should be well planned, careful and thorough. There should be no compromise with cancer, and tissues will have to be sacrificed

41. Haagensen, C. D., and Stout, A. P.: Carcinoma of the Breast, *Ann. Surg.* **116**:801-915, 1942; **118**:859-870 and 1032-1051, 1943.

when necessary. The surgeon should never tie his hands by committing himself to a promise to the distracted patient or relatives before operation. These persons should have trust in their surgeon's training and should rely on his judgment, which is surely bound to be better than their own. The surgeon should not be positive in his diagnosis and prognosis without microscopic evidence. He will save himself embarrassment by waiting for the sections, and many of the "cures" by quacks will thus be annulled.

A 73 year old minister entered the hospital in June 1936 (Strong Memorial Hospital case 115745). His history appeared to indicate that he had gastric carcinoma, and at exploration a mass was found on the posterior pyloric end of the stomach. What appeared to be metastatic lesions were present in the gastrohepatic ligament. A biopsy was taken of one of the lesions and closure made as it seemed to be an inoperable condition. He was discharged from the hospital with the impression that he had advanced cancer and that the outlook was hopeless. He went as soon as he could to a quack cancer clinic in a neighboring city. In the meantime the microscopic sections showed peculiar embryonic rests, with no evidence of cancer. He improved in health and became a fanatic advocate of the cancer cure. Nothing could shake his faith or devotion to this cause.

The surgeon should not give up a case as hopeless until he is sure. Many times it becomes possible to resect a lesion which appeared at first to be impossible of resection. Deeply fixed growths, however, are rarely operable, and digging them out is not good surgical practice. Radical operation should be done even in older persons if it is well considered because age is no longer a bar to careful surgical treatment. It should be remembered that growth is much slowed in the aged and that radical operation may not be necessary. Cancer of the breast, for instance, appears to behave like a different lesion in women beyond 70 years. I have a small series of such patients who have done exceptionally well for years after simple mastectomy. The same is true for some types of small polypoid carcinomas of the rectum for which local removal or radium implants have been successful. These decisions place a big responsibility on the surgeon, and he must know when to make the exceptions to the rules.

ROLE OF SPLENECTOMY IN THROMBOPENIC PURPURA

GEORGE BOGARDUS, M.D.

J. GARROTT ALLEN, M.D.

LEON O. JACOBSON, M.D.

AND

CHARLES L. SPURR, M.D.

CHICAGO

IDIOPATHIC thrombopenic purpura is a symptom complex characterized by petechial hemorrhages, thrombopenia, impaired clot retraction and prolonged bleeding time. Widespread internal hemorrhages may occur and cause the death of the patient. The symptom complex is frequently encountered, but the more seriously affected patients are comparatively rare.

Although Werlhof¹ is generally considered as having described this disease first, in 1775, it was Brohm² who, in 1883, first observed thrombopenia in a case of purpuric disease. It has been assumed that Werlhof's patient had thrombopenia; hence, the disease bears his name. Interest has centered chiefly on the role of blood platelets in this disease.

The existence of platelets was recognized by several workers in the early nineteenth century, but for many years their existence as real or as artificial blood elements was in controversy. It was the result of the collective researches of Zimmerman,³ Schultze,⁴ Osler,⁵ Bizzozero⁶ and Hayem⁷ that it became known that the platelets are part of the formed elements of the peripheral blood and that they are concerned with intravascular clotting. Both Hayem and Bizzozero

From the Departments of Surgery and Medicine, University of Chicago.

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1. Werlhof, P. G.: *Opera medica*, Paris, J. E. Wichmann, 1775, p. 748.

2. Brohm, cited by Quick.²⁴

3. Zimmerman, G.: *Ueber die Formgebilde des menschlichen Blutes*, *Mag. f. d. ges. Heilk.* **66**:171, 1846.

4. Schultze, M.: *Eim heizbarer Objektisch und seine Verwendung bei Untersuchungen des Blutes*, *Arch. f. mikr. Anat.* **1**:1, 1865.

5. Osler, W.: *An Account of Certain Organisms Occurring in the Liquor Sanguinis*, *Proc. Roy. Soc., London* **22**:391, 1874.

6. Bizzozero, G.: *Ueber einen neuen Formbestandteil des Blutes*, *Virchows Arch. f. path. Anat.* **90**:261, 1882.

7. Hayem, G.: *Leçons sur des maladies du sang*, Paris, Masson & Cie., 1900.

demonstrated that the first noticeable histologic change which followed injury to the vascular endothelium was the deposition, agglutination and, finally, disintegration of platelets at the point of endothelial injury. It was also noted that fibrin needles made their appearance so quickly after the platelet thrombus formed that it was difficult to be certain that the thrombus formation had actually preceded the appearance of fibrin. Hayem,⁷ in particular, realized the importance of the platelet as an essential part of the normal hemostatic mechanism and, in 1882, predicted that platelet deficiency might result in hemorrhagic disease.

The megakaryocytic origin of platelets was proposed by Wright,⁸ who presented a series of photomicrographs depicting the pseudopodial disintegration of megakaryocytes. Wright observed fragments of these pseudopods entering sinusoids of marrow spaces and called attention to the similarity in the staining qualities of the megakaryocytes and of the platelets. Most writers on the subject, including Howell⁹ and Morawitz,¹⁰ have stated the belief that the initiation of coagulation is largely dependent on the release of thromboplastin when platelets disintegrate.

PATHOLOGY

The pathologic features of thrombopenic purpura were described by Karsner¹¹ as (1) a slight increase in the megakaryocytes and normoblasts in the marrow, (2) hyperplasia and necrosis of the splenic follicles and (3) hemorrhagic manifestations. Much attention has been devoted to the spleen; yet these studies have been relatively fruitless. In many instances the spleen appears normal microscopically. Occasionally slight fibrosis, some edema or evidence of recent or of old focal hemorrhages is observed. The consensus among observers is that the pathologic picture is a disappointing contrast to the sometimes dramatic clinical course.

Other observations that relate to the pathology of thrombopenic purpura have been made on the marrow. When hemorrhage occurs, from whatever cause, the marrow is stimulated. This results in a general hyperplasia of the erythroid, myeloid and megakaryocytic elements of the marrow.

In thrombopenic purpura not associated with active hemorrhage, erythroid and myeloid hyperplasia is slight. The megakaryocytes con-

8. Wright, J. H.: *The Origin and Nature of the Blood Plates*, Boston M. & S. J. **154**:643, 1906.

9. Howell, W. H.: *The Nature and Action of the Thromboplastic (Zymoplastic) Substance of the Tissues*, *Am. J. Physiol.* **31**:1, 1912.

10. Morawitz, P.: *Beitrage zur Kenntnis der Blutgerinnung*, *Deutsches Arch. f. klin. Med.* **79**:1, 1903-1904.

11. Karsner, H. T.: *Human Pathology*, ed. 6, Philadelphia, J. B. Lippincott Company, 1942.

tinue to be numerous, however. It has been noted¹² that the megakaryocytes in purpura tend to be relatively young. The condition of the marrow may return to normal after splenectomy.¹² When splenectomy is unsuccessful and hemorrhage continues, the changes in the marrow may persist. It is difficult to determine which part of the change in the bone marrow results from hemorrhage and which part represents the primary disorder.

PRESENTATION OF CLINICAL CASES

The diagnosis of idiopathic thrombopenic purpura was established in the cases of 20 patients admitted to the University of Chicago Clinics during the past twenty years. Thirty-two other patients who had symptomatic thrombopenic

Results of Medical Vs. Surgical Treatment of Thrombopenic Purpura

Case	Age	Sex	Symptom	Initial Platelet Count	Results
Medically Treated Patients					
1	6 yr.	M	Frequent bruising	30,000	No bleeding in 7 yr.
2	14 mo.	M	Bleeding, several days	80,000	No bleeding in 6 mo.
3	1 mo.	F	Bleeding, 1 wk.	40,000	No bleeding in 2 yr.
4	6 yr.	F	Vaginal bleeding, 1 wk.	70,000	No bleeding in 2 yr.
5	7 yr.	F	Oral bleeding, 24 hr.	50,000	No bleeding in 2 yr.
6	36 yr.	F	Epistaxis, 2 yr.	90,000	No bleeding in 2 yr.
7	41 yr.	F	Epistaxis, 3 mo.	90,000	Recurrence
8	50 yr.	F	Menorrhagia, several years	65,000	Same petechiae
9	9 yr.	M	Epistaxis, 5 days	35,000	No bleeding in 2 yr.
10	22 yr.	F	Petechiae, 4 wk.	12,000	Recurrence
Surgically Treated Patients					
11	20 yr.	F	Petechiae, 2 mo.	130,000	No bleeding in 5 mo.
12	47 yr.	F	Menorrhagia, 3 yr.	65,000	Recurrence after 1 mo.
13	9 yr.	F	Epistaxis, 7 wk.	95,000	Good after 2 mo.
14	5 yr.	M	Bruising, 4 yr.	80,000	No bleeding in 5 yr.
15	2 yr.	F	Epistaxis, 3½ mo.	65,000	Slight epistaxis after 16 mo.
16	3½ yr.	M	Bruises, 1½ yr.	50,000	Recurrence after 1 yr.
17	21 yr.	F	Petechiae, 4 yr.	60,000	Recurrence
18	9 yr.	F	Petechiae, 6 mo.	32,000	Recurrence after 7 mo.
19	33 yr.	F	Epistaxis, 8 yr.	80,000	Postoperative death
20	37 yr.	F	Echymosis, 5 mo.	96,000	Occasional echymosis in 2 yr.

purpura secondary to other disease were also examined during this period. Data pertinent to the group studied are shown in the table.

Of this small group, 15 were girls or women. Fourteen of all patients were 22 years of age or younger. Ten of these patients were treated by splenectomy when bleeding persisted despite conservative measures. The remaining 10 patients were treated entirely by medical means. Uncontrolled bleeding was the chief indication for splenectomy. It is noteworthy that the platelet counts were comparable in the medically treated and in the surgically treated group.

The results of medical supportive therapy appear to have justified its use. Only 3 of the 10 patients so treated were known to have recurrences. The recurrences were present only in the older patients, in none of whom were they severe. The follow-up periods ranged from six months to two years.

Less satisfactory results were encountered in the 10 patients subjected to splenectomy. Six of these patients had a recurrence within one month to two

12. Dameshek, W., and Miller, E. B.: Megakaryocytes in Idiopathic Thrombopenic Purpura, Form of Hypersplenism, Blood 1:27 (Jan.) 1946.

years; in 2 of these patients it was severe. The recurrences developed irrespective of age. The length of the follow-up period for these patients was comparable to that of the group treated medically. There was 1 operative death in this group.

TREATMENT

The results of splenectomy in cases of this disease vary considerably in different clinics. The variable course of idiopathic thrombopenic purpura, characterized by its spontaneous remission and exacerbations, necessitates a prolonged follow-up period of years in order that any therapeutic procedure may be properly evaluated. The follow-up period in most of the reported cases, including our own, is too inadequate to permit a sound evaluation of splenectomy in treatment of this disease. Favorable results have been reported by many observers.¹³ On the other hand, there are workers who report equally satisfactory results from medical management¹⁴; some of these have also reported a high degree of recurrence following splenectomy.^{14a}

The data on results obtained with medical and surgical treatment by different workers are presented in the following tabulations. In 1936, Brown and Elliott¹⁵ recorded good results from splenectomy, as follows:

Result	Splenectomy	No Splenectomy
Complete arrest.....	4	3
Marked improvement.....	4	0
Improvement.....	1	2
No improvement.....	0	5
Death.....	1	1

Vaughan and Wright,¹⁶ in 1939, summarized the results in 59 cases, followed from five to fifteen and a half years, and concluded that in the great majority of the cases there was complete relief from symptoms and that the remissions had been permanent to the end of the observation period. Of 6 of their own patients with thrombopenic purpura, observed from ten to fifteen and a half years after splenec-

13. Wintrobe, M. M.; Hanrahan, E. M., Jr., and Thomas, C. B.: *Purpura Haemorrhagica*, with Special Reference to Course and Treatment, J. A. M. A. **109**:1170 (Oct. 9) 1937. Doan, C. A.; Curtis, G. M., and Wiseman, B. K.: *Hemolytotoxic Equilibrium and Emergency Splenectomy*, *ibid.* **105**:1567 (Nov. 16) 1935. Elliott, R. H. E., Jr.: *Revaluation of Splenectomy in Thrombocytopenic Purpura*, Proc. Inst. Med. Chicago **16**:330 (March 15) 1947. Eliason, E. L., and Ferguson, L. K.: *Splenectomy in Purpura Haemorrhagica*, Ann. Surg. **96**:801 (Nov.) 1932.

14. (a) McLean, S.; Kreidel, K., and Caffey, J.: *Hemorrhagic Thrombocytopenia in Childhood*, J. A. M. A. **98**:387 (Jan. 30) 1932. (b) Diamond, cited by Eliason, E. L., and Stevens, L. W.: *Surgery of Spleen in Blood Dyscrasias*, Surgery **13**:177 (Feb.) 1943.

15. Brown, D. N., and Elliott, R. H. E.: *Results of Splenectomy in Thrombocytopenic Purpura*, J. A. M. A. **107**:1781 (Nov. 28) 1936.

tomy, all continued to be free from bleeding phenomena at the time of the report, and 4 of these had normal platelet levels.

Wintrobe¹⁷ summarized the data in 151 cases as follows:

	Medical Treatment		Splenectomy	
	Number	Per Cent	Number	Per Cent
Results of treatment during first episode				
Immediate results				
Recovery.....	33	61.1	19	79.2
Improvement.....	19	35.2	..	....
Death.....	2	3.7	5	20.8
Totals.....	54	100.0	24	100.0
Late results				
Continued (over four years).....	8	17.0	13	76.5
Continued recovery (under four years).....	6	12.8	3	17.7
Symptoms or signs in varied degree.....	33	70.2	1	5.8
Totals.....	47	100.0	17	100.0
Results of treatment during or after later episodes				
Continued recovery (over four years).....	5	22.7	34	46.6
Continued recovery (under four years).....	3	13.6	9	12.3
Symptoms or signs in varied degree.....	10	45.5	22	30.1
Death.....	4	18.2	8	11.0
Totals.....	22	100.0	73	100.0

These data indicate that the chances for continued recovery following conservative or medical treatment were less than 1 in 3. After successful splenectomy, on the other hand, the chances for continued recovery were almost 3 in 4 when there had been only one episode of bleeding and somewhat better than 1 in 2 when several episodes had occurred before operation. Wintrobe and his associates stated the belief that recurrence may be associated with accessory spleens.

Giffin¹⁸ reported that from March 7, 1923 to Jan. 1, 1927, at the Mayo Clinic, splenectomy was performed on 20 patients with thrombopenic purpura. The observation period after operation was between five and nine years. There was no operative mortality. Thirteen of the 20 patients had the chronic moderately severe type of the disease; 3 were operated on during an acute exacerbation of the chronic disease; 3 were in the incipient stage of the acute disease, and 1 was in the incipient stage of the moderately severe form. All of these patients were living and in good or fair health without recurrence except for 1 patient who had died of a recurrence of severe metrorrhagia at puberty, five years after splenectomy. The 3 patients operated on during acute exacerbations of the chronic disease were well nine, six and five years respectively after splenectomy. The 3 patients with the

16. Vaughan, S. L., and Wright, T.: *Purpura Haemorrhagica, with Especial Reference to Permanence of Remission Following Splenectomy*, J. A. M. A. **112**:2120 (May 27) 1939.

17. Wintrobe, M. M.: *Clinical Hematology*, Philadelphia, Lea & Febiger, 1942, p. 623.

18. Giffin, H. Z.: *Essential Thrombocytopenic Purpura*, Tr. A. Am. Physicians **47**:218, 1932.

incipient acute type of the disease, operated on during the first attack, were well six and a half, five and a half and five years respectively after operation; the patient with incipient disease of moderate severity was found to have pulmonary tuberculosis three years after operation, and four and a half years after operation this patient apparently was cured.

In 1927 Spence¹⁹ published the results of splenectomy in 101 cases of thrombopenic purpura. He found good results, with no recurrence of hemorrhage, in 69 cases, and in 6 cases there was considerable improvement; in 21 cases death followed the operation, while in 5 cases the hemorrhages continued, with but slight improvement. He summarized his results as follows:

	Acute Type	Chronic Type	Unclassified
Good results			
No recurrence.....	2	61	6
Improvement.....	0	6	0
Poor results.....	0	5	0
Deaths.....	10	8	3

Whipple,²⁰ in 1926, collected 81 cases and reported deaths in 6 of the 73 cases of the chronic type and in 7 of the 8 cases of the acute type in which operation was performed. Of the 61 cases in which follow-up studies were made, the results were good in 51, fair in 4 and poor in 6.

In 1935, Pemberton²¹ recorded 57 cases of patients treated with splenectomy and stated that splenectomy often had proved a life-saving measure by initiating almost immediate remission of the disease; in 35 of the cases this remission was permanent. In 20, the remission was followed by one or more episodes of mild bleeding. In only 1 case did the disease recur in the acute form. The operative hazard in the chronic form of moderate severity was nominal, and in the incipient acute and recrudescent acute forms the mortality rate was 18 per cent.

COMMENT

One of the important aspects of idiopathic thrombopenic purpura is the relationship between the platelet count and the bleeding tendency. There has been much speculation about a critical platelet level. It has been variously estimated to be from 70,000 to 100,000 per cubic millimeter of blood. There is some evidence, however, that this is not the sole criterion of bleeding.

19. Spence, A. W.: Results of Splenectomy for Purpura Haemorrhagica, *Brit. J. Surg.* **15**:466 (Jan.) 1928.

20. Whipple, A. O.: Splenectomy as a Therapeutic Measure in Thrombocytopenic Purpura Haemorrhagica, *Surg., Gynec. & Obst.* **42**:329, 1926.

21. Pemberton, J. de J.: Diagnosis and Treatment of Purpura Hemorrhagica, *Proc. Staff Meet., Mayo Clin.* **9**:532 (Sept. 5) 1934.

Case 10 (fig. 1) in our series is a good example of the fact that the platelet count may remain low while the patient is still not bleeding. The patient was observed for a ten month period, a platelet count being made every two weeks. This count ranged from 11,000 to 70,000; yet only on three occasions did she exhibit petechial hemorrhages. During the bleeding phases there was no particular change in the platelet count. It would appear that in this case factors other than the platelet count were responsible for the bleeding episodes.

The next factor of considerable importance is the prolonged bleeding time in idiopathic thrombopenic purpura. Accurate technic is indispensable, as otherwise a false impression may be obtained. When

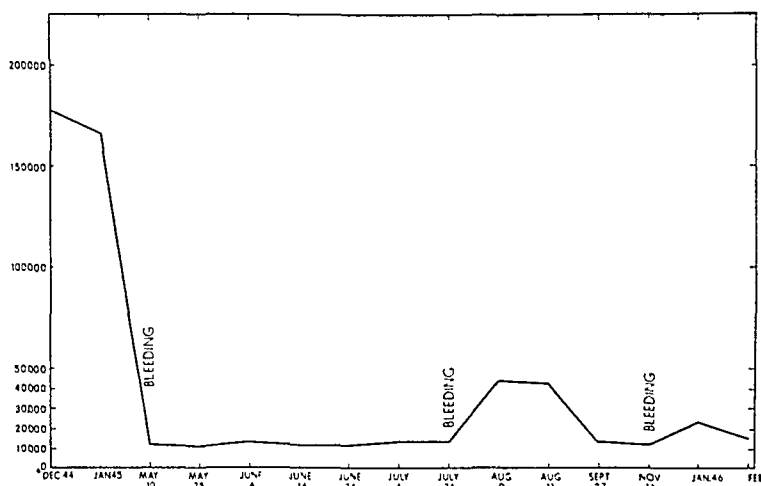


Fig. 1.—This chart indicates times of bleeding and platelet level per cubic millimeter of blood (case 10). Hemorrhage did not depend on a specific platelet level.

the puncture of the ear lobe is adequate, the bleeding time is usually found to be prolonged. Women patients often, but not invariably, bleed excessively during menstruation. Prolonged, and occasionally serious, nasal hemorrhage occurred in at least 2 of our patients when evidence of petechial hemorrhage was absent. Excessive menstrual bleeding and nasal hemorrhage associated with thrombopenia are in part clinical manifestations of prolonged bleeding time, which is the result of defective platelet thrombus formation.

As noted previously, a platelet thrombus is the first apparent response of the blood to vascular trauma. Ordinarily, there is a rapid deposition of platelets at the site of endothelial injury; very shortly this is followed by deposition of fibrin. Together, these two processes "plug up the leak," and hemorrhage is controlled. It is reasonable to assume that when the circulating platelets are diminished in num-

ber, as in thrombopenia, this repair process may be retarded to some extent, and a prolonged bleeding time may result.

Poor or entire absence of clot retraction is the third factor in thrombopenia. None of our patients had normal clot retraction when the platelet number was greatly reduced. The work of Tocantins²² suggests that normal clot retraction may depend on the number of intact platelets which may persist in the thrombus after fibrin is formed: He found that extracts of platelets added to the blood of patients with thrombopenia did not correct impaired clot retraction, but that when intact platelets were added normal retraction did occur.

Elliott²³ stated that petechial hemorrhages in idiopathic thrombopenic purpura appeared to be more closely correlated with increased capillary fragility than with the actual platelet level. The diminished integrity of the capillary wall is particularly evident in ambulatory patients. In such cases gravity throws an added burden on the capillary wall, resulting in occurrence of petechiae chiefly in the lower extremities (fig. 2). The platelet counts were occasionally reduced to hemorrhagic levels without evidence of bleeding, and under these conditions the tourniquet (capillary resistance) test gave negative results. On the other hand, the hemorrhagic aspect of the disease was always in remission when the platelet count returned to a normal level. In the absence of petechial or traumatic hemorrhage, our patients were clinically in good health regardless of the platelet levels.

It is not known just what defect in the capillary wall gives rise to petechial hemorrhage. While this defect has not gone without consideration, the platelet count has received greater attention. Clinically, at least, the capillary defect is probably more important than the platelet count. Unless the platelets are normally concerned in the maintenance of capillary integrity, it may be that the thrombopenia and the increased capillary permeability in this disease are distinct and different manifestations of a more fundamental, and as yet unknown, disturbance. Quick²⁴ suggested that a low grade overproduction of histamine in this disease might explain both the thrombopenia and the increased capillary fragility. Dale and Laidlaw²⁵ and Hanzlik

22. Tocantins, L. M.: Mechanism of Hemostasis, *Ann. Surg.* **125**:292 (March) 1947.

23. Elliott, R. H. E.: Suction Test for Capillary Resistance in Thrombocytopenic Purpura, *J. A. M. A.* **110**:1177 (April 9) 1938.

24. Quick A. J.: *The Hemorrhagic Diseases and the Physiology of Hemostasis*, Springfield, Ill., Charles C Thomas, Publisher, 1942.

25. Dale, H. H., and Laidlaw, P. P.: Histamine Shock, *J. Physiol.* **52**:355, 1918-1919.

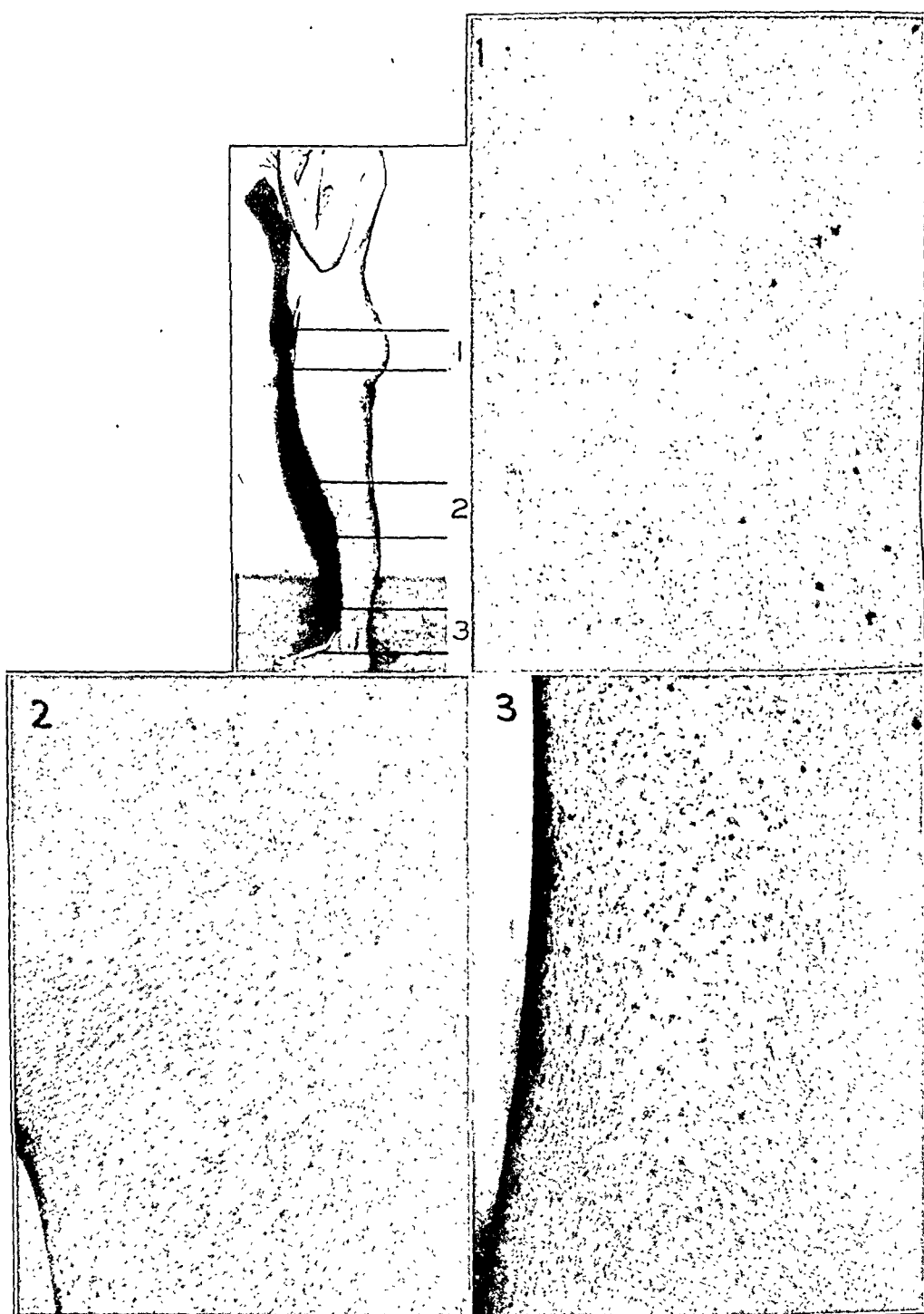


Fig. 2.—These photographs illustrate the increase in number of petechiae in the more dependent portions of the body (case 10). Enlargements 1, 2 and 3 are from the portions indicated in the full body view.

and Karsner²⁶ have observed the clumping and trapping of platelets in capillaries, causing thrombopenia after injection of histamine. That histamine can increase capillary permeability is also well established. There is, however, no evidence that blood histamine is increased in idiopathic thrombopenic purpura, although it might be increased in amounts too small to detect by present day methods.

In general, two explanations for the thrombopenia have been suggested: (1) toxic suppression of megakaryocytic activity²⁷ and (2) increased destruction of platelets.²⁸ Both theories postulate some form of hypersplenism. If the spleen alone were involved, splenectomy should produce consistently good results. Unfortunately, this has not been the case. The failure of splenectomy to produce permanent results in all cases is even suggested by Kaznelson's original experience,²⁸ in which good results were obtained in only 1 of 3 splenectomized patients. Similar experience has been reported by many clinics, and, while reports differ in the degree of failures following splenectomy, it is evident that hypersplenism alone does not account for all the factors. Some workers²⁹ have attempted to explain failures on the basis of the regeneration of splenic tissue or of the hyperplasia of accessory spleens missed at the time of operation.

Capillary fragility in purpuric disease has been tested in a number of ways. The commonest methods employ either some form of negative pressure applied to a standard area of the skin or a means of increasing the intracapillary pressure by partial constriction of the venous blood return from the forearm. We have used the constriction method and have noted the presence or absence of petechial hemorrhage in the more dependent portions of the lower extremities of ambulatory patients as an additional guide to the state of capillary permeability.

Most writers have stated the belief that splenectomy is the treatment of choice in the severer cases of thrombopenic purpura. The results have been good, though they have not always been successful. The

26. Hanzlik, P. J., and Karsner, H. T.: Further Observations on Anaphylactoid Phenomena from Various Agents Injected Intravenously, *J. Pharmacol. & Exper. Therap.* **23**:173, 1924-1925.

27. Torrioli, M., and Puddu, V.: Recent Studies on Pathogenesis of Werlhof's Disease, *J. A. M. A.* **111**:1455 (Oct. 15) 1938. Troland, C. E., and Lee, F. C.: Preliminary Report on Platelet-Reducing Substance in Spleen of Thrombocytopenic Purpura, *Bull. Johns Hopkins Hosp.* **62**:85 (Jan.) 1938.

28. Kaznelson, P.: Verschwinden der hämorrhagischen Diathese bei einem Falle von essentieller Thrombopenie (Frank) nach Milzexstirpation: Splenogene thrombolytische Purpura, *Wien. klin. Wchnschr.* **29**:1451, 1916.

29. Watson, C. J., and Moir, W. W., Jr.: Recurrence of Thrombocytopenic Purpura After Splenectomy in Case with Accessory Spleen, *Internat. Clin.* **4**: 221 (Dec.) 1941.

failures may have occurred in those cases in which the diagnosis was in error, though some failures have been reported by all workers. However, two factors remain to be explained: (1) Thrombopenia may return in a few weeks or months after splenectomy even when a careful search has been made for accessory splenic tissue, and (2) petechiae or spontaneous bleeding does not always accompany the reappearance of the thrombopenia. With regard to the first point, if the spleen were the only organ affected, its removal should produce a cure in all cases provided, of course, that the diagnosis of idiopathic thrombopenic purpura is correct. Such cures have not been the rule; the rates of recurrence have varied from 5 to 60 per cent.³⁰ With regard to the second point, one can state only that patients with

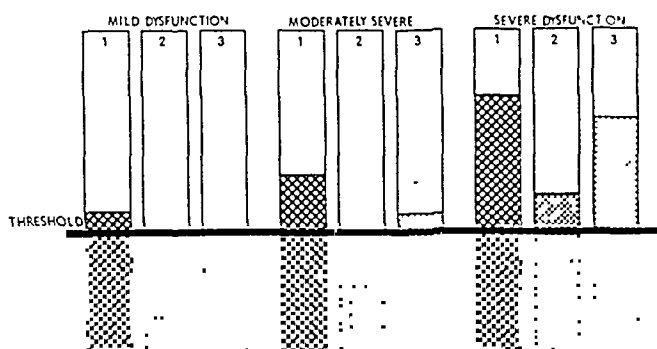


Fig. 3.—This chart indicates theoretic ratios between the degree of dysfunction of the reticuloendothelial system and the results of splenectomy. Splenectomy need not produce consistent results. Preoperative conditions, 1; immediate postoperative results, 2; long term postoperative results, 3.

thrombopenia purpura may have remissions from bleeding without change in the platelet count.

A possible explanation, accounting for most of these discrepancies, is that the disease involves the entire reticuloendothelial system. This suggestion is not new.²⁰ It could explain how accessory splenic tissue may be responsible for failure following splenectomy, as well as why splenectomy is successful in most cases. Presumably, splenectomy in most cases removes enough of the reticuloendothelial tissue to produce a good result. Latent compensatory changes in the remainder of the reticuloendothelial system might in some cases be sufficient to permit its disturbed function again to produce thrombopenia and/or hemorrhages. Spontaneous fluctuations in the activity of this system could explain the variable course of the disease. Figure 3 is a diagrammatic sketch of this concept.

SUMMARY

Clinical data based on 20 cases of idiopathic thrombopenic purpura are presented. Ten of the patients in this group were treated medically, and 10 were subjected to splenectomy. Seven of the 10 patients treated medically were known to have had no recurrence for a period of six months to two years. Five of the 10 splenectomized patients had a recurrence; in 2 of these patients it was severe. Of the patients who had a recurrence, 3 had the acute disease and 2 the chronic disease.

Opinions concerned with the pathologic processes in thrombopenic purpura are discussed. The importance of the capillary abnormality, as well as the low platelet count, is emphasized. It is possible that the condition of the entire reticuloendothelial system, and not of the spleen alone, determines the course of the disease.

30. Kaznelson.²⁸ Watson and Moir.²⁹

MULTIPLE ARTERIAL EMBOLI

Three Successful Embolectomies in a Case of Bacterial Endocarditis

H. WILLIAM SCOTT Jr., M.D.

AND

J. MAXWELL WILLIAMS Jr., M.D.

BALTIMORE

IN THE thirty-six years since Labey¹ of France (1911) performed the first successful arterial embolectomy, widespread experience with this procedure has demonstrated its practical importance in prevention of gangrene and death from embolic obturation of systemic arteries. Prior to 1930 interest in this field was largely limited to the work in Scandinavian clinics, but in recent years many peripheral embolectomies have been performed in this country. Reviews of the surgical advances in treatment of arterial emboli have been made by Key² (1936), Haimovici³ (1937), Linton⁴ (1941), Pratt⁵ (1942) and McClure and Harkins⁶ (1943). These authors described the clinical and pathologic features of arterial embolism and emphasized the desirability of prompt embolectomy. Murray⁷ (1940) stressed the advantage of giving heparin in conjunction with removal of the embolus.

Attempted embolectomies for repeated arterial emboli have been performed by a number of surgeons, but few successful cases have been reported. Deitch⁸ (1936) removed an embolus from the left femoral artery with good result, and a year later in the same patient emboli were successfully removed from the right femoral and the left common

From the Departments of Surgery and Medicine of the Johns Hopkins University School of Medicine and the Johns Hopkins Hospital.

1. Labey, G., cited by McClure and Harkins.⁶

2. Key, E.: Embolectomy on the Vessels of the Extremities, *Brit. J. Surg.* **24**:350-361, 1936.

3. Haimovici, H.: *Les embolies artérielles des membres*, Paris, Masson & Cie, 1937, p. 336.

4. Linton, R. R.: Peripheral Arterial Embolism, *New England J. Méd.* **224**:189-194, 1941.

5. Pratt, G. H.: Surgical Treatment of Peripheral Embolism, *Am. J. Surg.* **56**:566-572, 1942.

6. McClure, R. D., and Harkins, H. N.: Recent Advances in the Treatment of Peripheral Arterial Embolism, *Surgery* **14**:747-797, 1943.

7. Murray, G. D. W.: Heparin in Thrombosis and Embolism, *Brit. J. Surg.* **27**:567-598, 1940.

8. Deitch, H. I.: Three Arterial Embolectomies in the Same Patient Including One in Each Femoral Artery, *Lancet* **1**:475-477, 1936.

iliac artery. Groth⁹ (1939) collected records of 6 cases of reembolectomy, in only 4 of which the operation had been successful in preventing loss of the extremity. MacFarlane¹⁰ (1940) reported a case of multiple emboli with four successful embolectomies.

In the last few years the prognosis for patients with bacterial endocarditis has apparently been greatly improved by the use of penicillin.¹¹ The following case is illustrative of the value of prompt embolectomy in three successive episodes of arterial embolism occurring in a young man with this disease.

REPORT OF A CASE

History.—P. W., a 23 year old white man, a laborer, was admitted to the Osler Medical Clinic of the Johns Hopkins Hospital on Feb. 20, 1947, because of chills, fever, loss of weight and weakness. He had had attacks of rheumatic fever at 8, 12 and 15 years of age. One year before admission he had been confined to bed for three months with recurrence of rheumatic fever and had since been unable to return to work because of extreme exertional dyspnea. Seven weeks before entry he had noted the onset of fever and shaking chills, profuse night sweats and lassitude. A week later he had been operated on by his local physician for an anal fissure, and shortly after operation there had developed a spiking fever and migratory polyarthritis, relieved to some extent by salicylates.

Physical Examination on Admission.—His temperature was 101.6 F., his pulse rate 112, his respiratory rate 28 and his blood pressure 140 systolic and 40 diastolic. He was thin, apprehensive and dyspneic. His skin and mucous membranes were pale. Careful daily search revealed no petechiae. There was no general glandular enlargement. The teeth were in good repair, and the pharynx was normal. The lungs were clear. The heart was markedly enlarged in all its salients, the rate being rapid and regular, with a loud, coarse aortic diastolic murmur and a short presystolic rumble at the apex in the anterior axillary line. There were pronounced peripheral signs of aortic insufficiency. No palpable abdominal masses or viscera and no clubbing or edema of the extremities were present. There was evidence of a slight amount of fluid in the left knee joint the day after the patient's admission.

Laboratory Examinations.—The serologic test for syphilis gave a negative reaction; the hemoglobin measured 11.5 Gm. per hundred cubic centimeters; the red blood cell count was 3,650,000; the hematocrit reading, 35; the corrected sedimentation rate, 18 mm. per hour, and the white blood cell count, 11,000, with a normal differential count. The urine was normal. The electrocardiogram was within normal limits. Twelve blood cultures taken during the patient's first three days in the hospital were positive for *Streptococcus viridans* (mitior), the count being approximately 150 colonies per cubic centimeter. The nasopharyngeal culture

9. Groth, K. E.: Einige Falle von rezidivierendes Arterienembolie in der Extremitäten, Arch. f. klin. Chir. **194**:413-457, 1939.

10. MacFarlane, J. A.: Multiple Emboli Treated Surgically, Brit. M. J. **1**: 971-972, 1940.

11. Keefer, C. S.: Chemotherapy in Management of Medical Infections, Chicago M. Soc. Bull **49**:500, 1947.

yielded no pathogenic organisms. At the time of the patient's admission the blood chemistry was as follows: nonprotein nitrogen, 31 mg., and sugar, 111 mg. per hundred cubic centimeters; chlorides, 103.2 milliequivalents; cholesterol, 88 mg. per hundred cubic centimeters; carbon dioxide, 21.2 milliequivalents; bilirubin, total 1.8 mg. per hundred cubic centimeters, with 0.8 mg. in the direct test; and serum protein, 5.1 Gm. per hundred cubic centimeters, with an albumin-globulin ratio of 2.9:2.2. The venous pressure was 95 mm. of water; the circulation time (arm to tongue), thirteen seconds ("dehydrocholic acid; decholin") and the vital capacity, 55 per cent of normal. Phenolsulfonphthalein excretion was 84 per cent in two hours. The cephalin flocculation test gave a negative result, and the reading in the thymol turbidity test was 6.2 units. Agglutination tests for brucellosis, tularemia, typhoid and paratyphoid gave negative reactions in all dilutions.

Course in Hospital.—On his admission it was felt that the patient had rheumatic heart disease with mitral stenosis and aortic insufficiency, acute rheumatic fever and, probably, bacterial endocarditis. While growth of the blood cultures was awaited, treatment with salicylates was started and the patient was digitalized. While the patient was receiving salicylates, the temperature descended to a lower range, and he felt a great deal better.

On February 24, after identification of the organism from the blood culture (Str. mitior) administration of penicillin was started, 100,000 units being given every two hours (1,200,000 units daily). Cultures of blood after treatment was begun remained sterile until that taken on March 4, which grew Str. mitior. On March 6 the dosage of penicillin was doubled (200,000 units every two hours). All subsequent cultures of blood were sterile. Sensitivity of the organism to penicillin was found to be 0.24 microgram per cubic centimeter and penicillin blood levels at intervals of fifteen, thirty, sixty, and one hundred and twenty minutes after injection of 200,000 units were found to be 5.0, 5.0, 3.7 and 3.7 units, respectively, per cubic centimeter.

There was one episode of acute pulmonary edema following gastric dilatation from surreptitious dietary indiscretion (6 oranges and 2 pints [1 liter] of ice cream on the afternoon of his birthday, March 4).

On March 13 at 4:30 p. m., while moving off the bedpan, the patient suddenly felt numbness, coldness and mild pain in the left foot. Examination showed pallor and coolness of the foot and absence of pulsations below the femoral artery on the left. In contrast, there were vigorous "water-hammer" pulses in the right foot and leg. The patient was immediately given papaverine hydrochloride (64 mg.) intravenously and morphine sulfate (16 mg.) subcutaneously. The surgical resident, who arrived within ten minutes, concurred in the diagnosis of embolism of the left femoral artery, and immediate embolectomy was decided on. Blood to be used in determination of prothrombin time was obtained and 300 mg. of dicumarol (3,3'-methylene-bis-[4-hydroxycoumarin]) was given orally before operation.

First Embolectomy (H. W. S. Jr.).—At 5 p. m., with the use of local anesthesia, the left femoral artery was exposed in Scarpa's triangle. The pulsations which had been felt in the artery before operation now proved to be of the transmitted type, and there was marked arteriospasm. A longitudinal incision 2 cm. in length was placed in the common femoral artery, which had been occluded with a bulldog clamp distally and a catheter proximally. There was no bleeding from the proximal segment. With a biliary stone forceps passed upward in the artery for 3 or 4 inches (7.5 or 10 cm.) above the inguinal ligament, a hard grayish white, bullet-shaped embolus 4 cm. in length was extracted, its removal being followed by a vigorous spurt from the proximal segment. A long, propagated thrombus was then

removed by suction from the distal segment and the arteriotomy opening closed with a continuous everting mattress suture of 00000 silk. After removal of the constricting devices, femoral pulsations were still feeble, and for this reason the arteriotomy wound was reopened and a second, smaller, embolus extracted with the stone forceps. Again there was vigorous bleeding proximally, and the arteriotomy incision was closed, after which procedure good pulsation returned to the foot.

After three or four minutes pulsation abruptly ceased in the exposed femoral artery; with considerable reluctance the surgeon opened the arteriotomy wound again and removed a third embolus in a manner similar to that described previously. After closure of the artery this time adequate return of circulation was maintained. The wound was then closed in layers with interrupted fine silk sutures. Lumbar sympathetic block was performed with a 2 per cent solution of procaine hydrochloride, and on the patient's return to the ward the foot had regained its warmth and color, with good pulsation in the popliteal, posterior tibial and dorsalis pedis arteries.

Postoperative anticoagulant therapy in the form of administration of heparin by continuous intravenous drip was given until the effect of the dicumarol was obtained. Administration of heparin was controlled by determination of clotting time every two hours. Clotting time was kept at fifteen to twenty minutes by giving 20 to 27 drops per minute of a 5 per cent solution of dextrose with added heparin, 600 mg. per liter. Pretreatment clotting time had been five minutes and prothrombin time twenty seconds. The use of heparin was discontinued after twenty-four hours, and dicumarol therapy was then maintained, the daily doses being calculated to keep the prothrombin time at 25 to 35 per cent of normal. The next five days were uneventful.

On March 8, at 5:30 p.m., while lying quietly in bed, the patient experienced a repetition of the signs and symptoms of embolus in the left femoral artery at the same level at which the other emboli had appeared. He received papaverine hydrochloride (64 mg.) intravenously at 5:40 p.m. and was immediately taken to the operating room.

Second Embolectomy (H. W. S. Jr.).—With the patient under spinal anesthesia, the healing wound in the left groin was reopened and the common femoral artery exposed. A hard embolus could be felt just above the site of the original arteriotomy. With the same technic as that used before, the embolus was removed through a new incision 3 cm. above the site of the previous arteriotomy. There was no significant narrowing and no evidence of thrombosis at the site of the old arteriotomy. After this procedure vigorous arterial pulsations returned, and there have been no subsequent circulatory disturbances in this limb.

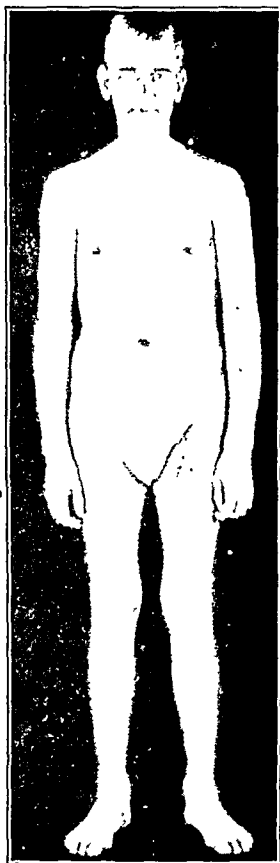
Cultures were made of this embolus by first suspending it in broth and then triturating it with sterile emery, thus culturing the entire embolus. Both cultures remained sterile. Papaverine hydrochloride (320 mg. daily, injected intravenously) and dicumarol had been given since the first operation, and their administration was continued. Despite complete rest in bed and maintenance doses of digitoxin U. S. P. (0.2 mg. daily), the patient had several attacks of acute pulmonary edema, requiring morphine, oxygen and tourniquets. Circulation in the legs remained excellent, and there were no further embolic phenomena until March 25.

On March 25 at 7:45 p.m. a severe shaking chill occurred, followed by an elevation of temperature to 104 F. and another attack of acute pulmonary edema. At 8:10 p.m. the patient suddenly complained of pain in the right foot, which rapidly became cold, numb and pulseless. Pulsations were absent below the level of the popliteal artery. After the administration of morphine, papaverine and oxygen,

a lumbar paravertebral sympathetic block was performed. By 10 p. m. the patient's cardiac status was improved sufficiently to permit his transfer to the operating room with a preoperative diagnosis of embolism of the right popliteal artery,

Third Embolectomy (H. W. S. Jr.).—With the patient again under spinal anesthesia, the right popliteal artery was exposed through a transverse incision, and a hard embolus 4 cm. in length was removed from the artery at its bifurcation. There was then prompt and complete return of circulation to the extremity.

After this procedure the patient's condition remained surprisingly good, and the temperature fell from a peak of 106 F. to normal by morning. Because of another



P. W., three months after three successful arterial embolectomies for recurrent peripheral embolism of the left femoral and right popliteal arteries, occurring during bacterial endocarditis.

chill and elevation of temperature to 103 F. on the following day the penicillin dosage was increased to 400,000 units every two hours (4,800,000 daily). Cultures of blood during these elevations of temperature remained sterile. Prothrombin time was twenty-five seconds (50 per cent of normal) on March 27, and no further dicumarol was given. On April 2 all skin sutures had been removed and the wounds were healed nicely. The reassuring "water-hammer" pulses were present in both legs and feet, and there has been no further evident impairment of the peripheral circulation.

The next complication came in a different form. On the night of April 2 the patient was awakened by a sudden pain in the left upper abdominal quadrant, which required morphine for relief. The lungs were clear, and the heart beat was unchanged, but a friction rub and exquisite tenderness in the left portions of the flank led us to suspect a splenic infarct. By morning the pain had become sharply localized in the midabdomen and was accompanied with signs of generalized peritonitis. The white blood cell count had risen to 19,500, and roentgenograms of the chest suggested paralytic ileus, with no free air under the diaphragm. Because of the previous embolic episode, a diagnosis of mesenteric infarction appeared most likely, and it was felt that operation was indicated. Laparotomy revealed diffuse purulent peritonitis, but no source could be demonstrated. Careful examination of the abdominal viscera revealed no evidence of infarction, perforation or localized infection. Appendectomy was performed as a precautionary measure. Immediate smears of the odorless exudate revealed no organisms, and cultures on various mediums remained sterile.

After the operation the patient received streptomycin (0.3 Gm. every two hours) and sulfadiazine (1 Gm. every six hours) intravenously for twelve days, in addition to penicillin (400,000 units every two hours). No satisfactory explanation of the origin of the peritonitis was ever established. The patient's recovery from the peritonitis was slow and often uncertain, but surprisingly good for one who had as low a cardiac reserve as his and had already been subjected to so much. The course of convalescence was extremely stormy and was complicated by numerous episodes of pulmonary edema and signs of pulmonary infarction.

To date (July 1, 1947) he has had no subsequent phenomena of peripheral embolism. Use of penicillin was discontinued on April 20, after he had received a total of 324,000,000 units, and his blood cultures remain sterile. He is now ambulatory, but with restricted activities because of his cardiac status. The circulatory, motor and sensory status of his extremities has remained intact (figure).

COMMENT

A discussion of the incidence, pathogenesis and diagnosis of arterial embolism exceeds the scope of this report. As summarized recently by McClure and Harkins,⁶ the optimal treatment of peripheral arterial emboli involving the lower extremities is prompt embolectomy, with local anesthesia, supplemented by lumbar sympathetic block and use of papaverine and anticoagulants.

The reported case illustrates the value of prompt recognition of the situation in repeated episodes of peripheral embolism and the desirability of close cooperation between medical and surgical services in utilizing this plan of treatment. Arterial embolism is a true surgical emergency, and a markedly diminished cardiac reserve should not be a deterrent to arterial embolectomy, with local or regional anesthesia.

Lumbar sympathetic block was not performed before the second embolectomy because a spinal anesthetic, accomplishing the same purpose, was given almost immediately. It is of interest to note that during the second and third embolectomies no excessive bleeding was encountered, despite the fact that the patient was fully dicumarolized. All wounds healed by first intention without hematoma or ecchymosis.

Major embolic phenomena occurring during the course of bacterial endocarditis are usually visceral.¹² Large peripheral emboli occluding the major vessels of the extremities apparently have been uncommon. Several observers¹³ have noted an increased incidence of embolism since the advent of intensive penicillin therapy of this disease. It is possible that in the future, cases of the type reported here will be more frequently encountered.

Johns Hopkins Hospital (5).

12. Libman, E., and Friedberg, G. K.: Subacute Bacterial Endocarditis, in Christian, H. A.: Oxford Medicine, New York, Oxford University Press, 1947, vol. 2, pt. 2, chap. 10a.

13. King, J. T.: Personal communication to the authors.

LIGATION OF CAROTID ARTERIES FOR ADVANCED MALIGNANT NEOPLASMS OF THE HEAD AND NECK

ALLISON J. VOSSELER, M.D.

AND

BERNARD J. FICARRA, M.D.

BROOKLYN

THE management of patients with advanced malignant neoplasms often necessitates an emergency surgical procedure. In the treatment of eroding neoplasms of the head and neck, ligation of the major arteries supplying these anatomic areas may become a necessity for the preservation of life. In these circumstances it may be indicated to ligate the common carotid artery or the external carotid artery, and sometimes certain of its branches.

Ligation of these vessels is advocated (1) to protect against bleeding, as a preliminary step to a radical surgical procedure on the head or neck; (2) to control active hemorrhage, and (3) to diminish the blood supply to inoperable neoplastic lesions, in the hope of decreasing the tumor growth and/or of preventing bleeding.

Specifically, the common carotid artery may be ligated to control profuse hemorrhage from the deeper structures of the upper cervical regions, as well as from ulcerating neoplasms in the throat. This artery has also been ligated in order to interrupt the circulation through an aneurysm. Usually the external carotid artery is ligated as a preparatory procedure in extensive operations on the face and neck. This is a precautionary measure prior to the resection of carcinoma of the upper jaw or excision of malignant lesions from the pharyngeal wall. Ligation of the internal carotid artery is rarely performed in the surgical management of carcinoma of the head and neck. This artery was not ligated in any of the cases presented in the current series.

PREOPERATIVE CONSIDERATIONS

Prior to ligation of any of the carotid arteries the most important preoperative consideration is the carotid sinus syndrome. The role of the carotid sinus has been proved to be a reflex-controlling mechanism

From the Department of Head and Neck Surgery, Brooklyn Cancer Institute.

of the endovascular blood pressure. The dilated portion at the bifurcation of the common carotid artery is the site of origin of this reflex, through innervation of the adventitia of the vessel.

Ligation of the carotid artery may produce a carotid sinus syndrome which results in episodes of unconsciousness and/or convulsions. These attacks may result in cerebral depression of the blood pressure.

In order to avoid this complication when surgical ligation of the carotid artery is contemplated, the following preoperative measure is recommended. The artery on the side of future operations should be compressed each day for a gradually increasing period up to ten minutes. This means that the carotid artery on the side of operation can be compressed for a total of ten minutes without any undue symptoms. It is, of course, appreciated that in the presence of an emergency to save life in case of hemorrhage this procedure cannot be followed. In these circumstances, and in sensitive persons, injection of 0.5 per cent procaine hydrochloride may be made into the carotid bulb. The solution is injected at the bifurcation of the carotid artery, where the sensory receptive fibers originate. Here the nerve leaves the sinus as the intercarotid nerve (nerve of de Castro) to join the glossopharyngeal nerve. Through this pathway the afferent nerve connection between the carotid sinus and the medullary center¹ exists. Injection of procaine hydrochloride blocks this nerve reflex and abolishes the possibility of the carotid sinus syndrome.

OPERATIVE APPROACH TO THE CAROTID ARTERY

The surgical approach to the carotid arteries is by means of an incision along the anterior margin of the sternocleidomastoid muscle. The center of the 8 cm. incision is at the level of the cricoid cartilage. Retraction of the sternocleidomastoid muscle posteriorly brings into view the omohyoid muscle inferiorly. This muscle may be divided if necessary. The descending hypoglossal nerve is retracted laterally. For more adequate exposure the thyroid gland may be drawn medially if necessary. This enables the common carotid artery to be more easily identified. Silk ligatures may then be placed about the artery with ease. In the course of this procedure care must be taken not to include the vagus nerve.

The same approach is employed for the external carotid artery. The site of selection for ligating this vessel is between the superior thyroid and the lingual artery. On occasion we have ligated both the carotid artery and the lingual artery. The landmark in choosing the site of ligation of the external carotid artery is at the level of the greater horn

1. Carotid Sinus Syndrome, editorial, J. A. M. A. **132**:24 (Sept. 7) 1946.

of the hyoid bone. In ligating the external carotid artery, the superior laryngeal nerve must be avoided. This structure lies behind the artery.

The cervical portion of the internal carotid artery is identified through the same procedure as that used for exposing the external carotid artery. In our own experience, we have never had occasion to ligate the internal carotid artery alone. In the cases presented the arteries were ligated with black silk. We have done ligations on these

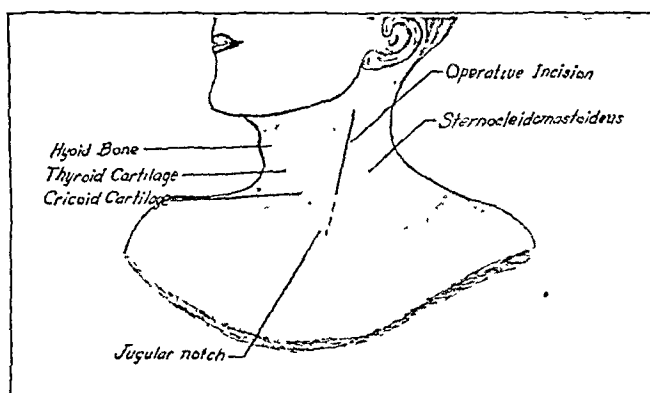


Fig. 1.—Operative approach to the carotid arteries. The hyoid bone is a landmark for ligating the external carotid artery.

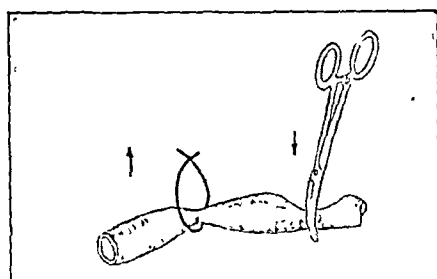


Fig. 2.—Method of gradual arterial compression by pulling upward on the ligature and pressing downward with a clamp.

vessels gradually in order to avoid sudden fall in cerebral circulation. This method of gradual occlusion of the vessel is also prophylaxis against the stimulation of the carotid sinus. By this means of occlusion, the silk ligature is drawn upward and the artery pushed downward with a clamp. The method enables release of the artery in the event that unusual symptoms referable to the carotid sinus develop. A sudden rise in the pulse rate may occur at the time of ligating the vessel. With this particular procedure the arterial circulation can be returned immediately by removing the closed clamp and lowering the black suture.

Data on 26 Cases with Advanced Malignant Neoplasms of Head and Neck in Which Carotid Arteries Were Ligated

Case No.	Age, Yr.	Sex	Pathologic Condition	Arteries Ligated	Eventual Outcome
1	62	M	Carcinoma of buccal mucosa	Left external carotid proximal to superior thyroid	Patient had complete right hemiplegia with aphasia 9 days after operation; died 3 years later in psychiatric institution
2	47	M	Squamous cell carcinoma of extrinsic part of larynx	Left external carotid	Thirty-three days after operation patient bled for 2 days from operative site, in spite of pressure; died of exsanguination
3	52	M	Squamous cell carcinoma of hypopharynx	Fifty per cent contraction of left common carotid; bifurcation in tumor tissue	Patient had tie on left common carotid artery tightened 2 days after operation; 4 days after operation had symptoms referable to left eye, with funduscopic hemorrhage and loss of color vision; course rapidly downhill; patient died 11 days after operation
4	54	M	Squamous cell carcinoma of right side of lower lip	Right common carotid	Patient complained of headache, weakness and inability to swallow; died 11 days after operation
5	50	M	Squamous cell carcinoma of tonsil	Right common carotid	Patient recovered from operation but complained of pain in right ear, which could not be controlled except by sedation; died 30 days later
6	33	M	Adamantinoma of right side of mandible and maxilla	Right common carotid	Patient continued to have hemorrhage and died 7 days after operation
7	52	F	Carcinoma of tongue	Left common carotid	Pulsation noted in right temporal artery 2 days after operation; patient died at home 24 days after operation
8	60	M	Carcinoma of buccal mucosa on left side	Left external carotid	Patient survived operation; died at home 6 months later
9	72	M	Carcinoma of lower alveolar ridge	Right external carotid	Patient survived operation; followed in outpatient department; died at home 27 months later
10	53	M	Carcinoma of tongue	Left external carotid	Patient was transferred to Welfare Island 4 months after operation; no note on outcome
11	52	M	Fibrosarcoma on left side of neck	Left common carotid	Patient went into complete vascular collapse 8 days after operation, and died; no autopsy
12	77	F	Recurrent giant cell tumor of right side of mandible; fibrosarcomatous changes	Right external carotid	Patient died 1 hour after operation
13	62	M	Epithelioma of floor of mouth	Right common carotid	Patient survived operation; had resection of right side of mandible, followed by therapy and insertion of radon seeds; now living and well, with out recurrence, 1 year after operation
14	58	M	Carcinoma of floor of mouth	Right lingual and right common carotid	Patient died 3 months after operation
15	50	M	Carcinoma of floor of mouth	Left common carotid	Wounds sloughed badly; patient died 9 days after operation
16	50	M	Carcinoma of left alveolar ridge	Left external carotid	Patient's wound broke down; several severe hemorrhages occurred; course downhill; patient died 3½ months after operation
17	67	M	Carcinoma of floor of mouth	Right external carotid and right lingual	Patient recovered from operation; 4 weeks later had resection of right side of mandible; died of pneumonia 8 days later
18	64	M	Carcinoma of mouth and tongue	Left external carotid and left lingual	Patient continued to bleed; after 2 days went to operating room for ligation of opposite lingual artery; died on operating table, cause unknown

Data on 26 Cases with Advanced Malignant Neoplasms of Head and Neck in Which Carotid Arteries Were Ligated—Continued

Case No.	Age, Yr.	Sex	Pathologic Condition	Arteries Ligated	Eventual Outcome
19	59	M	Carcinoma of left alveolar ridge	Left external carotid	Twelve days after operation patient had spontaneous pneumothorax, which responded to supportive treatment; patient transferred to nursing home 42 days, and died 106 days, after operation.
20	51	M	Carcinoma of right side of tongue	Right external carotid	Patient recovered, was discharged, seen in outpatient department, readmitted in poorer state and transferred to Welfare Island; died 281 days after operation
21	40	M	Epidermoid carcinoma of lower lip	Right common carotid	Patient recovered from operation, was transferred to House of Calvary and died approximately 90 days after operation
22	60	M	Carcinoma of left tonsil	Left external and left common carotid	Pneumonia developed 24 hours after operation, controlled; patient discharged and died 216 days after operation
23	63	M	Carcinoma of right angle of mouth	Right common carotid	Patient grew progressively worse; died 64 days after operation
24	48	M	Carcinoma of right angle of mouth	Right common carotid	Patient died 90 days after operation at House of Calvary
25	69	M	Carcinoma of floor of mouth	Left lingual and left external carotid	Patient went to operating room for resection of left side of mandible 25 days after operation and died on 113th postoperative day
26	67	M	Carcinoma of tongue	Left lingual and left external carotid	Elevation of temperature, 2 days after operation, thought due to focal atelectasis and pneumonitis; patient died 6 days after operation

COMMENT

Our experience in ligating the carotid arteries for advanced malignant growths of the head and neck consists in 26 cases seen at the Brooklyn Cancer Institute. In this series the youngest patient was 33 years of age and the oldest 77. Twenty-four patients were men and 2 were women. All of them had advanced neoplasms. The majority were not satisfactory operative risks. The underlying pathologic conditions and their distribution were as follows:

Pathologic Conditions	Number of Cases
Carcinoma of the floor of the mouth.....	6
Carcinoma of the tongue.....	4
Carcinoma of the alveolar ridge.....	3
Carcinoma of the buccal mucosa.....	2
Carcinoma of the lip.....	2
Carcinoma of the tonsil.....	2
Carcinoma of the angle of the mouth.....	2
Carcinoma of the external portion of the larynx.....	1
Carcinoma of the hypopharynx.....	1
Fibrosarcoma of the neck.....	1
Giant cell tumor of the mandible.....	1
Adamantinoma of the mandible and maxilla.....	1

The operative procedure was performed on either the right or the left side, according to the location of the lesion. On one occasion

the left external carotid artery was ligated to control hemorrhage; but this proved ineffectual, and the left common carotid artery had to be ligated (case 22).

All the patients in this series had advanced lesions, as shown in the tabulation. With this primary pathologic condition, they were not considered the best type of operative risks. The expected mortality, therefore, would be high, not because of the procedure alone but in view of the fact that the patients were debilitated by long-standing neoplastic lesions. In our series the mortality was not unusually high. One patient died on the operating table. Another succumbed one hour after the operation. A third patient died on the second postoperative day, while another died on the seventh postoperative day. A fifth patient succumbed on the ninth postoperative day. The remaining 21 patients survived the immediate postoperative period and lived for several weeks to several years. The longest period of survival was three years. Another patient lived for twenty-seven months, and the third has been followed for one year and is living and well at the time of writing.

In view of the eventual outcome in this series of 26 patients, it is our belief that ligation of the carotid arteries in the presence of an advanced malignant growth is not a procedure associated with an exceptionally high mortality. It may be considered a valuable adjunct to the armamentarium of the cancer surgeon. There can be little doubt that for many of the patients subjected to this procedure the operation was life saving. With other patients radical surgical intervention would have been impossible without the preliminary step of ligating the major vessels of the neck.

SUMMARY AND CONCLUSIONS

A report is presented of 26 cases in which ligation of the carotid arteries was performed for advanced malignant neoplasm of the head and neck.

This procedure is advocated mainly to control hemorrhage and as a preliminary step to radical surgical procedures on the head and neck.

The importance of the carotid sinus syndrome in this procedure is mentioned.

The operative approach to the carotid arteries is discussed.

The survival of 21 patients in a series of 26 indicates that this procedure is not associated with a formidable mortality.

The youngest patient operated on was 33 years of age and the oldest was 77.

The procedure was performed on 24 men and 2 women.

The cases presented here are categorized according to the type of lesion present and the arteries ligated.

Follow-up studies on these patients to date indicate that the longest survival after operation is three years.

Ligation of the carotid arteries is advocated as a valuable asset in the management of patients with advanced malignant neoplasms of the head and neck.

Dr. Howard T. Craven compiled the data on the cases presented in this report.

567 First Street (15).

892 Park Place (3).

USE OF BARREL STAVE GRAFTS IN SPINAL FUSION

H. R. McCARROLL, M.D.

AND

RICHARD ODELL, M.D.

ST. LOUIS

HENRY and Geist¹ in 1933 reported a modified Hibbs type of spinal fusion in which multiple chip grafts from the tibia were used. This modification simplified the spinal fusion operation by assuring an adequate supply of bone which would conform to any curvature or angulation of the spine, at the same time causing less shock than attends a more extensive surgical procedure. In the procedure which they described, no attempt was made to remove the articular facets. This type of spinal fusion has now been used over a period of many years and has proved most satisfactory for both children and adults. One difficulty, however, has been encountered in obtaining the grafts and insuring that the desired amount of bone will be procured. In young children multiple chip grafts can be removed from the tibia smoothly and easily with a sharp gouge, since the bone is less sclerotic than that of older persons. In children 14 years of age and older and in adults, however, the bone of the tibia is usually denser, and the chip grafts are difficult to obtain. In some instances the attempt to do this is comparable to removing small chips from the surface of a piece of marble. This situation has resulted at times in loss of some of the bone chips, and on occasion in an insufficient amount of bone to cover adequately the area to be fused.

In an attempt to obviate the difficulty which was encountered in obtaining the multiple chip grafts, we have used recently the barrel stave grafts as described by Steele.² The barrel stave grafts are simply long strips of full thickness tibial cortex cut approximately $\frac{1}{8}$ inch (3 mm.) in width with a motor saw. These grafts may be placed either on edge or on the flat surface, and they are usually flexible enough to

From the Shriners' Hospital for Crippled Children and the Department of Surgery, Washington University School of Medicine.

1. Henry, M. O., and Geist, E. S.: Spinal Fusion by Simplified Technique, *J. Bone & Joint Surg.* **15**:622-625 (July) 1933.

2. Steele, P. B.: Treatment of Nonunion; Barrel-Stave Grafts, in Reconstruction Surgery, Lectures in the Instructional Courses, American Academy of Orthopaedic Surgeons, January 1944, Ann Arbor, Mich., Edwards Bros., 1944, p. 22.

be made to conform to any deformity or curve of the spine. If multiple chip grafts are desired, the long barrel stave grafts can be cut into small chips by means of a bone rongeur. Except for the alteration in the type of graft used, this technic for spinal fusion is carried out in exactly the same way as that described by Henry and Geist.¹ The procedure has been used repeatedly for fusion in cases of

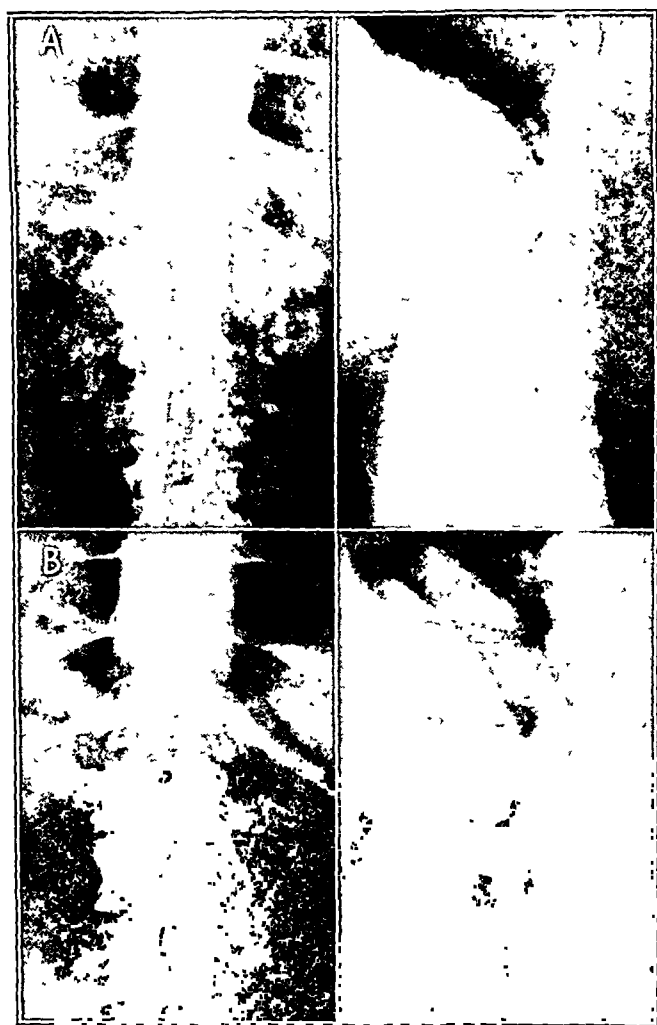


Fig. 1. (F. C., aged 38).—*A*, tuberculosis of the spine three months after arthrodesis by means of barrel stave grafts reenforced with multiple chips of iliac bone. Three long barrel stave grafts were used on each side, as can be seen in the roentgenogram at the left. *B*, one year after the operation. The barrel stave grafts can still be outlined, but increased new bone formation is visible in the lateral view.

tuberculosis of the spine (fig. 1), scoliosis (fig. 2) and spondylolisthesis (fig. 3), and occasionally for fixation of other lesions, such as hemangioma of the vertebra (fig. 4). In the present series of 25 cases,

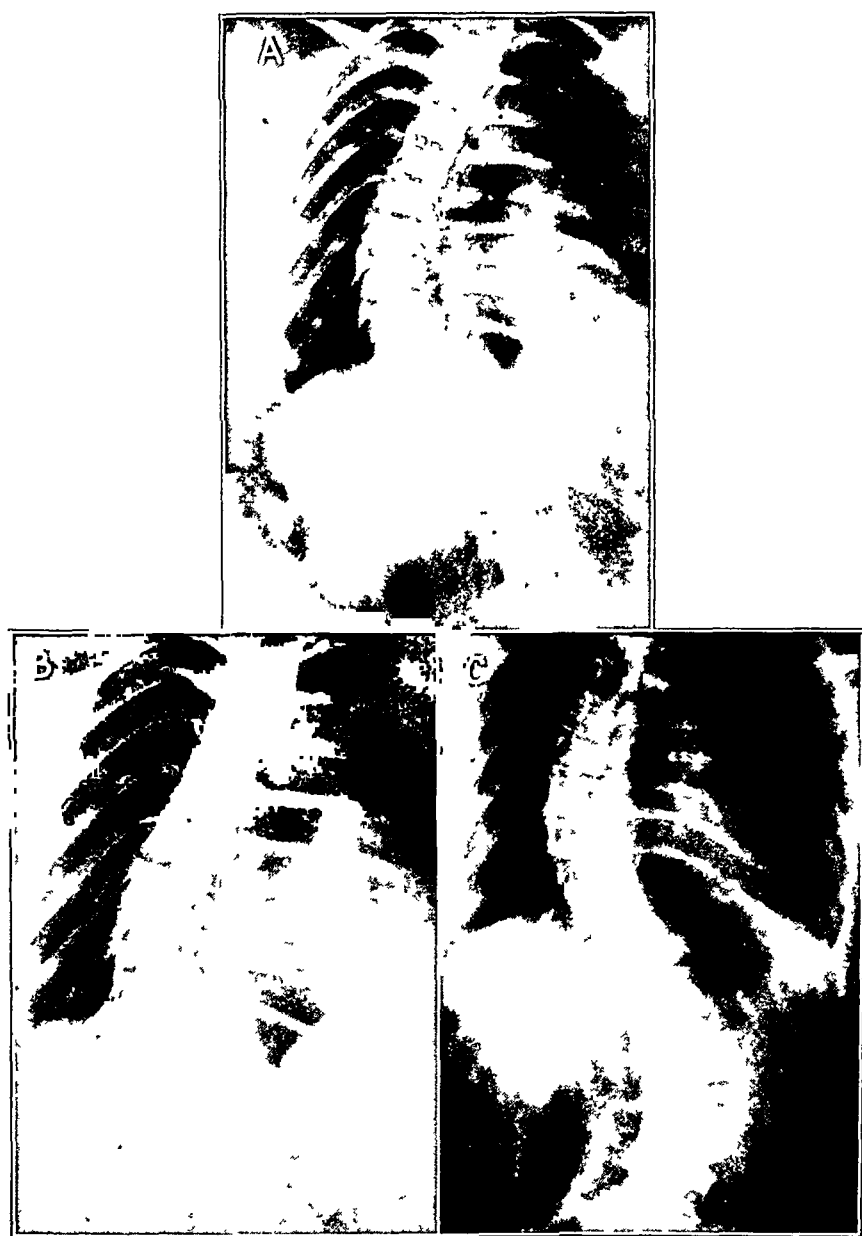


Fig. 2 (V. L., aged 15).—*A*, idiopathic scoliosis prior to institution of treatment *B*, the same spine nine weeks after the first stage of spinal fusion. Fixation and this degree of correction were obtained by means of a traction brace (Blount). Note that the barrel stave grafts on the concave surface completely bridge the concavity of the curve. *C*, appearance eleven months after the first stage, and nine months after the second stage, of spinal fusion. The barrel stave grafts have now lost their identity. Note the heavy deposits of bone on the concavity of each curve.

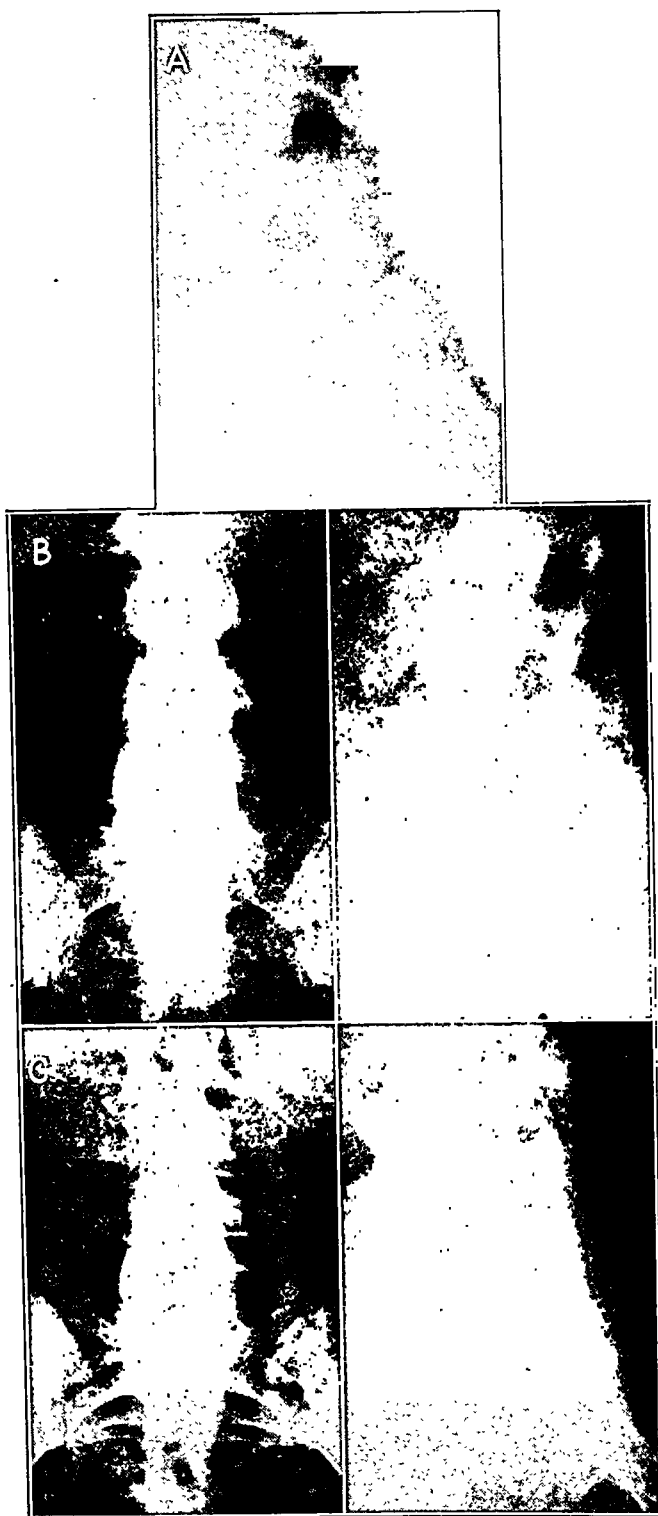


Fig. 3 (D. T., aged 43).—*A*, spondylolisthesis with pseudarthrosis following two previous spinal fusions, in which multiple chip grafts from the tibia had been used. *B*, six months after a third spinal fusion, in which barrel stave grafts reinforced with chips of cancellous iliac bone were used. Note the massive bone graft now spanning the defect. In the anteroposterior view the multiple barrel stave grafts are still visible. *C*, twenty months after the arthrodesis. Complete bony fusion is apparent. The identity of the barrel stave grafts is now being lost.

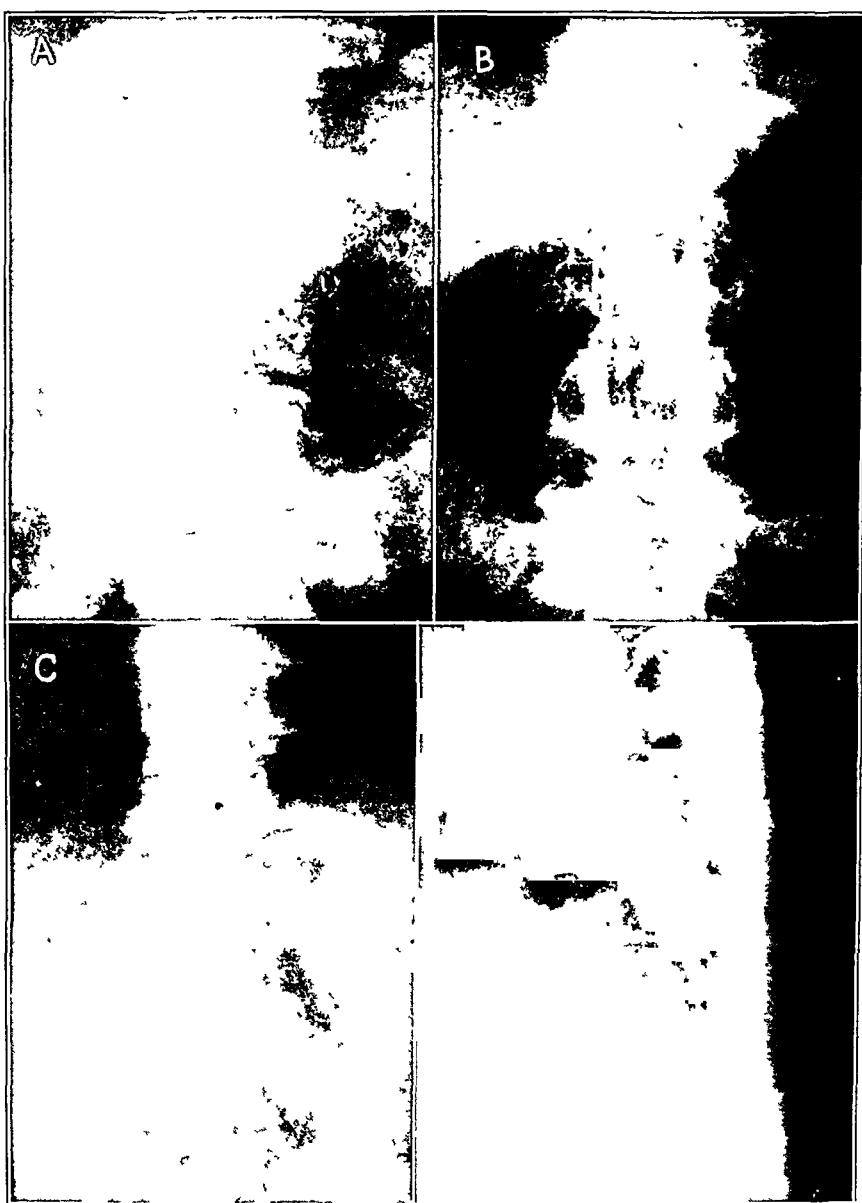


Fig. 4 (R. M., aged 58).—*A*, hemangioma of the twelfth thoracic vertebra. *B*, immediately after spinal fusion, in which barrel stave grafts reinforced with multiple chips of iliac bone were used. Six barrel stave grafts were used, and the three grafts can be identified on each side. *C*, one year later, when fusion seems satisfactory and the barrel stave grafts are losing their identity. In the lateral view, note the heavy mass of bone along the spinous processes.

excellent arthrodesis has been obtained in all except that of a child with spondylolisthesis which was associated with severe congenital osteochondritis. In this case a pseudarthrosis necessitated a second operation.

In many instances the barrel stave grafts have been reenforced with multiple chip grafts of cancellous bone removed from the posterior portion of the iliac crest. With a combination of this type, a more satisfactory spinal fusion can as a rule be expected than with either cortical or cancellous bone alone. It is possible that the incidence of pseudarthrosis and of postoperative fracture of the graft can be appreciably diminished by the use of a combined procedure of this type.

3720 Washington Boulevard (8).

HISTOLOGIC AND CHEMICAL ASPECTS OF THROMBUS FORMATION

ERNST FRIEDLANDER, M.D.
SAN JOSE, CALIF.

REGARDLESS of the methods preferred in the treatment of venous thrombosis, the physiologic events in the process of thrombus formation must guide the physician in his therapeutic considerations. What is called a vascular thrombus today was considered an outgrowth of the vascular wall by anatomists until the middle of the past century. Rudolf Virchow¹ was the first one to recognize these "outgrowths" as blood clots. He also described the mechanism of embolism, and his concept of thromboembolic disease is fundamentally as dominant now as it was one hundred years ago. Among the many papers which have appeared since Virchow's classic work, a few can be listed as contributing substantially to a better understanding of thromboembolic disease. Glénard² and von Baumgarten³ showed independently that blood does not clot, even if kept stagnant for days between ligatures applied to a vein, as long as the vascular lining remains intact. The Viennese biochemist Freund⁴ was able to demonstrate that even extravasated blood does not clot if collected under a paraffin film in a paraffin-lined container. However, the least defect in the water-repelling paraffin lining and film creates a condition favorable to clotting. Freund showed that the innermost vascular lining is water repelling, like paraffin. Any lesion of this lipid-like lining is a potentially germinative center of thrombus formation. Such lesions are frequently produced by processes closely related to allergy. As was pointed out by Dietrich,⁵ small aggregations of cells may arise in the venous endothelium as the effect of toxic substances produced by focal infections. These cellular aggre-

1. Virchow, R.: *Gesammelte Abhandlungen zur wissenschaftlichen Medicin*, Frankf. a. M., Meidinger Sohn u. Comp., 1856.

2. Glénard, F.: *Contribution à l'étude des causes de la coagulation spontanée du sang à son issue de l'organisme*, Paris, Ve. A. Delahaye, 1875.

3. von Baumgarten, P. C.: *Die sogenannte Organisation des Thrombus*, Virchows Arch. f. path. Anat. **76**:268, 1877.

4. Freund, E.: *Ein Beitrag zur Kenntniss der Blutgerinnung*, Med. Jahrb. **1**:46, 1886.

5. Dietrich, A.: *Gefässwand und Thrombose*, Verhandl. d. deutsch. Gesellsch. f. Kreislaufforsch., 1934, p. 48.

gations break up the lipid-like lining and roughen its surface. The identity and origin of the invading cells have not been determined yet. No micro-organisms have ever been found in these microscopic "Dietrich nodules" or in their vicinity. With advancing age the patient passes through a number of more or less serious focal infections and allergies, and the venous system acquires an increasing number of irregularities in its lining, although this condition may not cause any circulatory embarrassment for a long time.

Children up to the age of puberty normally possess efficient circulatory power, and the blood of the young easily passes over these minute entanglements. A man may accumulate toxic nodules throughout his life without the formation of a thrombus as long as the circulatory conditions remain favorable. If, however, some circulatory disturbance arises, then the blood secures a hold on a nodulous spot, and the formation of a thrombus commences.

Virchow considered a thrombus to be a blood clot identical in composition and structure to an extravascular clot. In about 1875, Zahn⁶ produced proof of the existence of an active, selective cellular process that initiates thrombus formation. In a series of ingenious and well planned experiments, he demonstrated the fact that a thrombus always starts with the accumulation of white blood elements, regardless of whether the causative irritant is mechanical or chemical. After placing a small crystal of sodium chloride on a frog's mesentery, he could see, within a short time, that all the blood vessels around the spot had become packed with white blood cells, the veins being obviously more involved than the arteries. When warm-blooded animals, such as rabbits, were subjected to this treatment, they showed similar reactions so far as the experiment was performed on an area of small veins.

Zahn then carried his experiments to the intravenous injection of a saturated solution of sodium chloride. He noted that first accumulations of white blood elements appeared at the site of the injections and settled around the injured places, often occluding the lumens of the vessels. Later, on the foundation provided by this white plug, blood coagulated and formed a common clot. Thus a thrombus was seen to consist of two principal parts: a white head, adhering firmly to the vascular wall, and a red tail, fixed by one end to the head, with most of its substances floating in the vessel. An intermediate portion, which contained more white cells than there are in a common clot, was usually interpolated between head and tail. In small veins the mass of the white head greatly exceeds that of the red tail. However, this proportion is reversed in larger veins, such as those of the caliber of the human saphenous or femoral vein, where the red tail forms almost the entire

6. Zahn, F. W.: Untersuchungen über Thrombose: Bildung der Thromben, Virchows Arch. f. path. Anat. 62:81, 1875.

body of the thrombus. In some cases a lesion of the endothelium is followed only by a leukocyte and platelet reaction, which does not give rise to the production of a red clot. Instead, there results a more or less uniform investment of white blood elements. The factors on which this formation depends are the caliber of the vessel, the size and kind of the lesion and the state of the local circulation.

I believe that the two stages of thrombosis as described by Zahn differ fundamentally in their biologic significance. The white plug represents a process of repair and healing related to the formation of scar tissue, while the red tail constitutes a pathologic reaction. With circulation of the blood unabated, as it usually is in children, a red tail does not form on the white plug. However, when the circulation slackens locally or generally, a red tail may come into existence at any time. The formation of both the white plug and the red tail seems to be preceded by a biochemical process, preparing a sticky medium. Dietrich⁷ described a delicate precipitate which first covers the injured lining. This precipitate shows no definite microscopic structure and does not take on Weigert's stain for fibrin. Consequently, I find it hard to accept Dietrich's conclusion that the mentioned precipitate is a true fibrinous substance. However, by a peculiar interaction of glucose, fibrinogen can be converted into a sticky gel phase without assuming qualities of fibrin.

As was pointed out by the Netherland authors Brinkman and van Dam⁷ and van Creveld and Brinkman,⁸ any irritation can produce pronounced changes in the surface of the corpuscular blood elements. According to the aforementioned workers, glucose is found only in the plasma, not in the corpuscular elements, if human blood is carefully collected under a paraffin film in paraffin-lined containers. At the least disturbance, however, glucose accumulates on the corpuscular surfaces. There it stays for hours, and even days, and it penetrates the corpuscular bodies only very gradually. The rate of penetration can be measured by the increase in size of the corpuscles. In experiments carried out at the Institute of Colloidal Chemistry at Vienna, Friedlander⁹ found that glucose, in a concentration twice or more that of the isotonic solution, converts the normal sol of fibrinogen into its gel phase, not allowing it to assume fibrinous qualities; i. e., the

7. Brinkman and van Dam: *Remarques sur la question de la répartition de la dextrose entre les globules rouges et le plasma*, Arch. internat. de physiol. **15**:105, 1919.

8. van Creveld, S., and Brinkman, R.: *Ein direkter Beweis für die Impermeabilität der Blutkörperchen des Menschen und des Kaninchens für Glukose*, Biochem. Ztschr. **119**:65, 1921.

9. Friedlander, E.: *Kolloidchemische Vorgänge bei der künstlichen und spontanen Thrombose*, Wien. klin. Wchnschr. **42**:1451, 1937.

fibrinogen clot does not take on Weigert's fibrin stain, and it does not retract.

If glucose concentrates at a small area of irritation on a blood corpuscle, it can easily produce a flake of fibrinogen gel, thus causing a local stickiness of the surface. As a matter of fact, Wöhlisch and Bohnen¹⁰ saw filaments of fibrinogen extending from one erythrocyte to another. Tannenbergs and Fischer-Wasels¹¹ have given an almost dramatic account of the effect of increasing stickiness acquired by white blood elements passing an area of irritation in a vessel. The fact that red tail formation has a much higher incidence in man than in animals is probably due, at least in part, to the difference in the relation of glucose to the erythrocytes in man and in animals as far as tested. According to the Netherland workers mentioned, glucose did not accumulate on the erythrocytes of their experimental animals.

To a certain extent the organism possesses regulative processes which counteract the conglutination of erythrocytes. As has been pointed out by the Finnish physiologist Hammarsten,¹² a sufficiently high concentration of an electrolyte, especially sodium chloride, prevents clot formation. This action holds true with regard to the formation of a fibrinogen gel as well as to that of fibrin. Under conditions of circulatory congestion the migration of chloride from the plasma into the cellular bodies is facilitated by an increased carbon dioxide tension, which is usually associated with venous congestion, and the negative charge of the chlorine ions helps to neutralize the positive charge of the fibrinogen. This observation may in part explain why a salt-free diet favors thrombus formation in diabetic patients, as Lapp and Dibold¹³ reported.

At present, therapeutic considerations are generally guided by the classification of thrombus formation into phlebothrombosis and thrombophlebitis, as proposed by Ochsner and his co-workers.¹⁴ These authors stated the belief that thrombophlebitis is due to a primary inflammatory process involving the wall of the vein and that the thrombus is secondary to the inflammatory process. They claimed that, because of the inflammatory process, the thrombus which is formed is a white thrombus and is firmly attached. There may occur a red, or coagulation,

10. Wöhlisch, E., and Bohnen, P.: *Mikroskopische Untersuchungen am Schwangerenblut*, *Klin. Wchnschr.* **3**:472, 1924.

11. Tannenbergs and Fischer-Wasels: *Die lokalen Kreislaufstörungen*, in Bethe, A., and others: *Handbuch der normalen und pathologischen Physiologie*, Berlin, Julius Springer, 1928, vol. 7, pt. 2, p. 1669.

12. Hammarsten, O.: *A Textbook of Physiological Chemistry*, Wiesbaden, J. F. Bergmann, 1893, p. 55.

13. Lapp, F. W., and Dibold, H.: *Thrombose und Embolie bei salzloser Kost*, *Deutsche med. Wchnschr.* **62**:1206, 1936.

14. Ochsner, A., and DeBakey, M.: *Therapy of Phlebothrombosis and Thrombophlebitis*, *Arch. Surg.* **40**:208 (Feb.) 1940.

thrombus, as a tail to this. This process, however, is similar to the process of phlebothrombosis. In phlebothrombosis, it is possible for the thrombus to become attached to the venous wall and ultimately lead, according to Ochsner,¹⁵ to thrombophlebitis.

To date, it has been a general belief, shared by the majority of authors of textbooks on pathology, that a stratum of white thrombus substance spreads over a comparatively wide area of venous lining preceding the coagulation of blood on the basis of this stratum. However, in studying histologic sections of varicose and other thrombi, I was puzzled by the rare occurrence of what could pass for a stratum of white thrombus substance. Areas of that sort were usually microscopically small. Later I found out that my observation was not new at all. On a material, larger and better selected than mine, Zahn⁶ had shown in 1875 that white plugs contribute the bulk of a thrombus only in small vessels, while their size diminishes rapidly with the increase of the vascular caliber. He found that in veins the size of the human femoral vein white plugs are usually so small that they often escape attention. Probably this fact was the reason that the process of white thrombus formation escaped entirely even Virchow's keen eyes. In larger veins the bulk of a thrombus is made up of the red tail, while the original white plug is very small. The histologic pictures of transections of mixed and white thrombi, seen in most of the American and European textbooks, are doubtless correct, but the texts say nothing about the incidence of the different formations.

I feel that practically every thrombus tail in a large vein starts as a floating body. It depends on the therapeutic management whether this body remains floating or gets attached along the venous wall. The secondary attachment of a thrombus tail occurs by a process different from that of white thrombus formation. When contacting the vascular wall, the thrombus is arrested in situ by the fibrin on its surface. Only much later can cellular immigration be seen, and the process of organization starts after a period of weeks. However, the first phase of attachment by fibrin seems to be sufficient as a protection against embolism. So far, not one case of pulmonary embolism has ever been found in which the embolus showed vestiges of previous attachment. By proper management the majority of floating thrombi can be brought to an attachment to the venous wall, thus fixing them to their original site, as shown in the treatment of thrombosis of the lower portion of the leg by Fischer¹⁶ and of femoral and pelvic thrombosis by Friedlander.¹⁷

15. Ochsner, A.: Personal communication to the author.

16. Fischer, H.: Eine neue Therapie der Phlebitis, *Med. Klin.* **30**:1172, 1910; Zur Therapie der Stauungen der unteren Extremitäten und ihrer Folgen, *München. med. Wchnschr.* **4**:116, 1923.

17. Friedlander, E.: Anatomische Grundlagen zur Behandlung der Beckenvenen- und Femoralisthrombose, *Wien. klin. Wchnschr.* **49**:1067, 1936.

At present the preference for surgical or for conservative treatment remains a matter of personal predilection. Both methods are effective in trained hands. Anticoagulants decidedly arrest clotting as long as the anticoagulant is administered, but they do not affect the thrombus already in existence and do not help attach the thrombus to the venous wall.

In either the surgical or the conservative treatment of venous thrombosis, the physician has always to take into consideration the fact that an old and well attached thrombus may become an embolic hazard by new appositional tail formation. General and local circulatory conditions have to be watched carefully in order that unnecessary accidents may be avoided.

SUMMARY

Stepping-stones in the research of thrombo-embolic disease are outlined.

The following aspects of thrombus formation are discussed: (1) the allergic factor ("Dietrich nodules") in thrombus formation; (2) the white plug and the red tail of a thrombus; (3) the fundamental biologic difference between the white plug and the red tail; (4) the significance of glucose distribution in thrombus formation; (5) the interaction of glucose and fibrinogen, and (6) phlebothrombosis and thrombophlebitis.

667 North First Street.

A COLOSTOMY BAG

New, Single Use, Disposable Bag with Individually Molded Collar

ADOLPH M. BROWN, M.D.

Associate, Illinois Eye and Ear Infirmary

CHICAGO

THE COLOSTOMY concept is one of the bravest and boldest in the history of medicine. This dramatic feat of physiologic engineering has saved countless lives, but the prospective possessor of a colostomy must view his future with disgust, especially since it is explained as inevitable. Anything to make his existence more tolerable is gratefully received by the patient.¹

In addition to the possibility of surgical complications, such as prolapse or stenosis, the imperfections of control of loss of fluid, fecal loss and gas make life miserable for the patient even though colostomy is the method used to effect a possible cure of a miserable disease. Even the best designed and executed colostomy opening is a severe household difficulty and social embarrassment.

Interest in the rehabilitation of the colostomized patient is of great sociologic, economic and psychologic importance.² These patients have often remarked that occasionally the surgeon fails sympathetically to evaluate the plight of one faced with the problem of using a colostomy bag. It is most important that the surgeon remain interested in the patient and help him manage his colostomy opening.³ In addition to giving proper instruction as to irrigation, diet and care of the skin, it is advisable that the surgeon actively supervise the selection of a bag or pad, as indicated by the case, and examine the ensemble for fit of belt, collar and bag.

The following points should be borne in mind:

The belt should be adjustable, should not rest or rub on the anterior superior iliac spine and should be easily detachable from the collar.

1. McLanahan, S.: Aluminum Paste and Skin Protector in Enterostomy, J. A. M. A. **108**:385 (Jan. 30) 1937. Shedden, W. M.: The Management of Permanent Colostomies, New England J. Med. **206**:792, 1932.

2. Gevinaus, F. C.: Proctology, New York, D. Appleton-Century Company, Inc., 1936, p. 601.

3. Martin, C. F.: Stricture of the Rectum, J. A. M. A. **101**:1550 (Nov. 11) 1933.

The cup should fit snugly enough to prevent herniation and prolapse. It should not be rigid.

Present day bags, which the patient must empty, wash, dry and reapply again and again, are revolting even to the esthetically callous patient. The bags are made of rubber and, since they have to be used every day, must be cleaned by washing or boiling and, to prevent odor, must be turned inside out and aired.

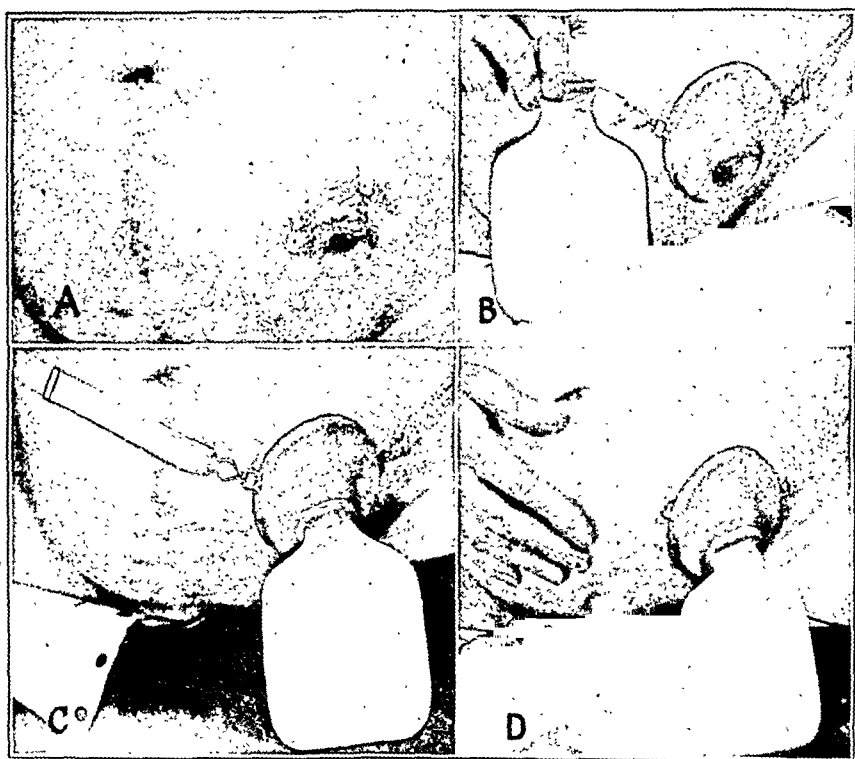


Fig. 1.—(A) A colostomy wound. The white areas surrounding the mucosa are flakes of colostomy bag cement. (B) The colostomy bag ensemble. The collar, sculpturally molded to fit the abdominal wall, is cemented to the skin with a special water-proof and perspiration-proof adhesive substance. It is further supported by an elastic belt, hooked as shown. The patient is holding the single use, disposable bag. (C) The single use, disposable colostomy bag in position. Gas escapes slowly through a small notch in the collar. (D) The colostomy ensemble cemented in place, without use of the elastic belt.

The purpose of this paper is to describe a colostomy bag with two significant features:

1. The bag itself is a single service container, to be used once and disposed of.

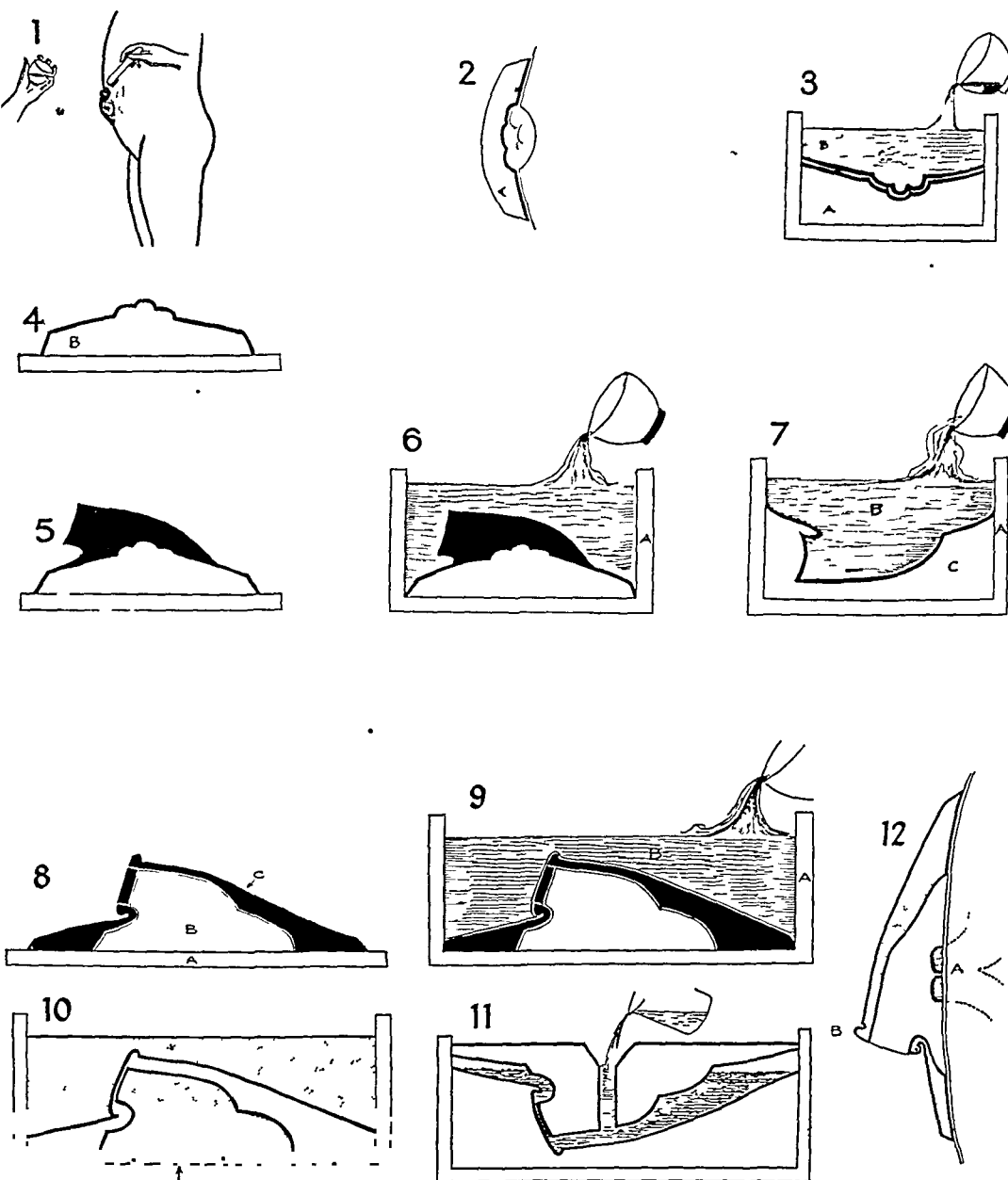


Figure 2

Fig. 2.—(1) An impression of the abdomen and colostomy area is obtained by applying an alpha gypsum mixture over the area, with the patient in the upright position. (2) The plaster of paris negative impression is permitted to dry and solidify. (3) The negative impression (*A*) is coated with separating compound and walled in "plasticine" or clay. It is then filled (*B*) with a plaster of paris mixture, which, when solidified, is separated from the negative impression. The negative impression is discarded. (4) The positive cast, or actual reproduction of the abdominal area bearing the colostomy opening, is thus made. On this, the colostomy bag collar will be modeled or sculptured. (5) The passageway, or core, of the collar is sculptured first, in clay, on the colostomy wound to form a positive impression. The black area thus represents the inside space, or core, of the colostomy ring. (6) Now a clay wall (*A*) is built around the clay core and plaster ensemble, and more alpha gypsum is poured over it to form a negative impression of the core. The negative is permitted to harden, and the positive impression of the area of the colostomy wound is temporarily set aside. (7) The negative just poured is turned upside down, a new clay wall (*A*) built around it, and more plaster mix (*B*) poured into its cavity. This forms a replica of the abdominal wall and the core of the colostomy collar. The plaster (*C*) is chipped away and discarded. (8) On the plaster base (*A*, here represented as flat) and plaster core (*B*), the collar is now sculptured in clay (*C*) around the plaster core. (9) Now a new clay wall is built around the plaster ensemble bearing its sculpture, and the mold is poured (*B*) with plaster to complete the mold. (10) This illustration represents the plaster mold and core, assembled after the clay has been washed out. Now, at the arrow a pouring channel will be cut through the back of the mold. (11) A liquid latex mixture is poured through the channel to complete the casting process. It will form a hollow collar, or ring, which will surround the colostomy wound and fit the abdomen exactly. It will support the neck of the colostomy bag, around its ring. (12) The completed colostomy collar is represented schematically in place. *A* represents the colostomy opening. The disposable bag fits over the ring (*B*). The ring (*B*) is also notched, but the notch is not represented. The notch permits accumulation of gas in the bag to be very slowly expelled spontaneously.

2. The collar of this colostomy bag is individually molded to fit the patient's abdomen at the site of the colostomy wound.

The bag is used once. When it is filled, it is simply removed from its collar, without contaminating the fingers, and dropped into the toilet bowl, to be flushed away. It is at once replaced with a duplicate, also without contamination of the hands. Bag replacements are carried in the pocket or purse and occupy no appreciable bulk.

As can be seen from the diagrams and photographs, the collar of this colostomy device is made by sculpturing its model directly on the plaster replica of the patient's abdomen. It is modeled directly over a cast of the colostomy opening, with its lumen varied to fit over the lips of the colostomy opening and the duct slanted downward to lead easily to the bag. Sculptors' clay is used for this purpose, as centuries of use have proved it as a modeling medium. Yet other materials, including pink dental wax or "plasticine," can be used for modeling.

The model is duplicated in natural rubber by the technic illustrated in figure 2. The collar will be found to adapt with a perfect fit into every configuration of the abdominal wall shouldering the colostomy wound. This fact is of special significance when one realizes that the colostomy site often is traversed with depressed or raised scars and, further, may be distorted by abdominal herniations. One such case is illustrated (fig. 3).

After one collar is sculptured, it can be used as a model for those of other patients.

It is difficult enough to please a patient with a colostomy opening by offering a colostomy bag. But, after he has tried stock bags, he shows gratitude indeed when this bag is offered. The feature of single service is gratefully received, and the idea of disposing of the bag without emptying it seems esthetically more desirable than what the patient previously has been accustomed to.

Once the bag is fitted, the patient has his choice of wearing the collar cemented to the abdominal skin, which measure insures a water-tight fit, or of supporting it snugly in place with an adjustable elastic belt. Or the patient may use both cement and the belt.

The bag fits over the flanged collar. The bulge is negligible. Patients who have formerly used the larger bags are grateful for this feature, for with it there is no telltale bulk evident through the clothing.

At present the bags are molded by dipping the positive plaster model into an aqueous dispersion of prevulcanized natural latex.⁴ The cement

4. The bags will be mechanically molded soon by a commercial dipping process, using an aluminum mold and a coagulating agent.

used to seal the colostomy collar to the abdominal skin is a latex dispersion mixture, such as the following:

	Per Cent
Aqueous dispersion of latex (40%).....	70
Zinc oxide	20
Storax	10
Oil of rose	

When the collar is cemented, the abdomen is cleaned with special care to eliminate oils or unguents from the skin. The inner face of the collar is painted with the cement, as is the corresponding area around the wound. It is then necessary to wait about half a minute until each surface is dry. All tackiness must be gone. Then, and not until then,



Fig. 3.—A, a colostomy collar sculpturally molded to fit a herniated abdominal site. B, the bag in place over the herniated area.

the collar is affixed to the site of the wound. The rubber adheres to rubber with a water-proof seal. Then the disposable bag is affixed to the flangelike neck of the collar.

One or two spare bags are kept in the pocket. An ordinary latex condom, everywhere available, may be used in an emergency. This ensemble was the first I devised. The spare bags are dusted within with a deodorant powder, such as that made by the following formula:

Zinc peroxide	35.0
Boric acid	20.0
Bentonite	10.0
Oil of rose	0.5
Talc	100.0

The powder also prevents adhesions of rubber within the bag.

1260 Lake Shore Drive (10).

Surgical Clinics

COMPLICATIONS OF INJECTION OF THOROTRAST IN THE CAROTID ARTERY

DEPARTMENT OF SURGERY, GEORGE WASHINGTON UNIVERSITY SCHOOL OF MEDICINE
WASHINGTON, D. C.

DR. BRIAN BLADES: A few weeks ago we saw in this clinic a case in which there was a mass in the neck and some manifestations of pressure, which apparently had followed an injection of "thorotrast" (colloidal suspension of thorium dioxide). Our interest has been aroused in this subject, and it is somewhat amazing to find that 3 similar cases are being observed in this hospital and 1 in the George Washington Hospital and that Dr. Bradley has also observed a case, which he will describe today. We shall have the privilege of hearing Colonel Berman, of Walter Reed Hospital, who, with his associates, has collected several cases.

The first case will be presented by Dr. Abrahams.

DR. HARRY ABRAHAMS: Mrs. C. S. is 38 years old and has had epileptiform seizures since the early part of March 1946. She was admitted to the Neurological Service in the course of one of these seizures in the latter part of March 1946, and a carotid arteriogram was attempted. Shortly after this attempt was made, she noted a mass on the right side of her neck, which she described to be about the size of a quarter. This mass has gradually increased in size since that time. It caused no symptoms until about two weeks ago, when she noted that it had become painful and tender to the touch. She also noted that her speech had become somewhat thicker and that she could not enunciate as distinctly as formerly.

Her epileptiform seizures have been recurring approximately twice a month, the last attack having occurred two weeks ago. She has been receiving "dilantin" (diphenylhydantoin sodium) therapy since admission.

The laboratory examinations revealed nothing significant. The reactions to the Kahn and Wassermann tests were negative.

The noteworthy features of the physical examination are confined to the neck, where a mass is palpable under the right angle of the mandible. It extends from the angle anteriorly and medially for a distance of approximately 8 cm., almost to the midline. The widest portion of the mass is posterior, being about 3 cm. in diameter. The anterior portion narrows down to between 1.5 to 2 cm. The mass is roughly pear shaped. Its surface is smooth, and its consistency almost woody. It is fixed and is not tender to palpation.

The roentgenologic findings of note are confined to the neck, where radiopaque material is scattered throughout the tissues, most of it being located under the angle of the jaw.

DR. BLADES: A second and somewhat similar case will be presented by Dr. Kelly.

DR. JAMES L. KELLY: A 21 year old white woman was admitted to Gallinger Hospital on Nov. 4, 1942.

The history indicated that while in school she had fallen off a chair and injured her head. One week prior to her admission headaches developed, and because of nuchal rigidity she was admitted to the Neurological Service, where a diagnosis of a cerebral aneurysm was made. It was believed that a carotid arteriogram was indicated. This was attempted unsuccessfully, and there was extravasation of "thorotrast" into the fascial planes of the neck. A carotid arteriogram was performed on the left side. After this there developed an acute inflammatory process in the neck; she was examined by members of the resident staff, who believed that immediate operation was not indicated. A hard mass



Fig. 1.—Radiopaque "thorotrast" in the neck extending upward into the region of the oral pharynx and downward into the superior part of the mediastinum.

has been present for the past four years in the left side of the neck. Increasing hoarseness has been present for one year. There has also been increasing dysphagia. The mass has been growing somewhat larger during the past few years.

Physical examination revealed no abnormalities except in the left side of the neck. There was a firm, fixed, smooth, stony hard, nontender mass extending from the submaxillary region down to the clavicle. The voice was hoarse. Examination of the heart, lungs, abdomen and extremities was noncontributory.

The past history was not remarkable except that two years ago material from a small lump in the right side of the neck was taken for biopsy at Emergency Hospital. Pathologic examination of this tissue was reported to show neurofibromatosis. Laboratory studies have revealed nothing abnormal.

You will note that there is extravasation of the "thorotrast" medium into the fascial planes of the neck in these three roentgenograms.

Roentgenograms of the neck (fig. 1) revealed a mass of opaque material in the left side of the neck, extending from above the level of the mandible downward into the superior mediastinum of the chest.

DR. BLADES: Dr. McCune, since you operated on this patient, will you describe your findings at operation?

DR. WILLIAM MCCUNE: Because of the fact that this patient had been complaining of progressive dysphagia, dyspnea and hoarseness with a gradually increasing firm mass in the left side of her neck, it was decided that a radical resection of all tissues containing "thorotrast" should be performed. Consequently, with the patient under general intratracheal anesthesia and in the supine position with the neck extended, an incision was made from the tip of the chin to the left mastoid process, an extension being made downward to the suprasternal notch and laterally along the upper border of the clavicle. Skin flaps thus outlined were dissected back, which exposed the entire left side of the neck from the trachea to the trapezius muscle. Directly under the skin was a mass of firm, almost hard tissue infiltrating all the structures of the neck, especially about the carotid sheath. The mass extended downward below the level of the clavicle and upward above the larynx behind the ramus of the mandible. It was difficult to dissect out the different structures of the neck because all were infiltrated by the mass of tissue. The transverse incision above the clavicle was deepened down to the scalenus muscles, which exposed the trunks of the brachial plexus, the phrenic nerve and the internal jugular vein. By upward traction on the mass of tissue, it was possible to remove that portion of it which lay in the upper part of the thorax. It was carefully dissected off from the internal jugular vein and from the carotid artery. Directly over the common carotid artery was a small space which was free of the "thorotrast" fibrosis. The internal jugular vein was divided at the upper border of the clavicle and the entire mass of tissue dissected upward off from the common carotid artery. The trachea was encased in a mass of the tissue, which was dissected with difficulty. The vagus nerve was completely involved and could not be saved. Consequently the left vagus nerve was sacrificed. The superior cervical sympathetic chain was dissected free. It was apparently unharmed. The left lobe of the thyroid gland was resected. The hypoglossal nerve was densely involved in scar. The scar was resected from the nerve and the nerve reanastomosed. The esophagus was carefully freed from the fibrotic process and the dissection carried upward to the region of the oral pharynx. The posterior wall of the oral pharynx was completely involved in fibrotic scar (fig. 2), and in the attempt to free this scar from it the pharynx was inadvertently opened. The scar was removed from all areas except a small patch on the posterior wall of the pharynx itself. The pharynx was closed with silk sutures in two layers. The entire mass of tissue was removed. The skin layers were closed with silk, two drains being left in the wound. The patient returned to the ward in good condition.

Postoperatively, there was a considerable degree of tracheal and laryngeal edema, which lasted for several days. This gradually subsided, the wound healed well and the patient is now symptom free. The hoarseness has not increased above that which she had before operation. There is a moderate degree of Horner's syndrome, apparently due to dissection about the cervical sympathetic chain. Postoperative roentgenograms (fig. 3) revealed no thorium-containing tissue except in the posterior wall of the pharynx. In that area only a small bit of radiopaque material can be seen.

DR. BLADES: The third case will be presented by Dr. Eastman.

DR. WILFRED EASTMAN: This is the case of Ida K., who sits before you. She came to this hospital a little over a month ago complaining of having had



Fig. 2.—*A*, operative photograph showing (*A*) trachea, (*B*) common carotid artery, (*C*) cervical sympathetic trunk, (*D*) mass of "thorotrast" fibrosis with band of fibrous tissue, (*E*) extending downward between esophagus (*F*) and trachea. *B*, photograph after removal of fibrous scar tissue which extended into the posterior wall of the pharynx; *A*, trachea, *B*, bifurcation of common carotid artery, *C*, sympathetic trunk, *D*, phrenic nerve, *E*, suture beginning closure of pharynx.

unconscious spells. At the time of admission she was in just such a state. She had been having similar attacks for approximately three years and had never had them before that.

She was admitted to the neurological service for study. In the course of this study a carotid arteriogram was performed on the left side on Nov. 10, 1947, with the use of "thorotrast." This arteriogram, however, was not entirely successful, and postoperatively some roentgenologic evidence of extravasation of "thorotrast" into the tissues was discovered.

After the arteriogram was made she had some pain in her neck for approximately twenty-four hours, but after that there were no symptoms. There was no postoperative swelling, and no tumor could be felt. The remainder of the history is noncontributory except that she has hemorrhoids, for which she was transferred to the surgical service two days ago.



Fig. 3.—Postoperative roentgenograms of patient in figure 1 after radical dissection in the neck. "Thorotrast" has been removed entirely.

Her physical condition is otherwise normal except for mild hypertension and generalized arteriosclerosis. No mass can be palpated in the neck, and there is no localized tenderness. Hemographic and laboratory studies show no abnormalities.

This is the roentgenogram of the neck. It shows nothing in the mediastinum, but "thorotrast" is obviously present in the left side of the neck.

DR. BLADES: Three representative cases in which injection of "thorotrast" into the neck occurred have been presented. Dr. Tom Bradley has recently operated on a patient in whom "thorotrast" was used in the antecubital fossa. Dr. Bradley, will you please present your case?

DR. TOM BRADLEY: A girl was admitted to Children's Hospital in November 1935 for the removal of a large tumor mass beneath the right axilla. In an effort to diagnose this tumor mass, it was thought best to inject "thorotrast"

intravenously to see if the tumor filled. She had previously had an angiosarcoma in the same location, and we had been confused in the diagnosis. The tumor turned out to be a cystic hygroma.

At the time the "thorotrast" was injected into the cephalic vein of the right arm some was spilled into the tissues. I heard that it had been spilled, and, knowing that it was radioactive, I made a transverse incision across the antecubital fossa and attempted to get as much of it out as I could.

From then on, a mass developed at the site of the injection which slowly became larger and at times painful, especially after trivial injuries.

One week ago excision of this mass was undertaken. I made an incision which started in the upper part of the arm on the outer surface over the cephalic vein and extended down the arm and transversely across the antecubital fossa and then down the inner side of the forearm. The two flaps were reflected back, and I removed a mass of tissue of the consistency almost of bone, with some difficulty, and severed the anterior brachial cutaneous nerve, which has produced partial anesthesia extending down the forearm.

There have been no motor or sensory changes other than that. Examination prior to the operation had shown a perfectly normal forearm and hand. There has been no evidence of sloughing.

DR. BLADES: Dr. Klopp, of the Warwick Clinic, has consented to be with us today and to describe a case in which he has recently performed an operation.

DR. CALVIN T. KLOPP: The patient is a 60 year old Negro woman, from whom, incidentally, we have never been able to get a history of ever having had an injection of "thorotrast." She was admitted to the hospital with the complaint that six months previously she had had some dysphagia and hoarseness. About five months prior to her admission, some dimness of vision had developed in her right eye. Four months before her admission she experienced difficulty in breathing through her nose.

All these symptoms progressed until she finally presented herself at Episcopal Hospital, where examination revealed that she had a large nodular mass in the nasopharynx extending down the posterior pharyngeal wall until it could actually be seen beneath the uvula. There was nothing palpable in her neck. She had mild proptosis on the left side and moderate proptosis on the right.

She was sent to the Warwick Clinic after a diagnosis of malignant tumor was made. We also believed this diagnosis to be correct. However, twelve biopsies were performed, all of which showed chronic inflammatory change. Roentgenograms were taken of her skull. You will see two things. One line follows the carotid sheath, and in addition there is a destructive lesion seen at the base of the skull finely mottled with what was first thought to be calcium. The point was brought up that while this might represent some kind of chondrosarcoma it was difficult to explain on the basis of an injection of "thorotrast."

Because of the interest of one of the radiologists, we resected this portion of the carotid sheath which was somewhat fibrotic but otherwise did not look in any way abnormal. Specimens were sent to the Bureau of Standards, which verified the belief (1) that there was radioactivity which fogged a photographic plate and (2) that the radioactivity was alpha activity. They are also in the process of proving that it is thorium, but, as they put it, if it has activity it certainly is not uranium and it is not radium, so it must be thorium.

During the patient's stay in the hospital, she has lost the sight of her right eye completely and has almost lost the sight of her left eye. She has atrophy of the left optic nerve and papilledema in the right eye. It is difficult to know

whether or not anything can be done for her. One week ago she had an episode in which for twenty-four hours she was unable to be roused, and we thought we were going to solve the problem. However, she recovered spontaneously and has since been all right.

If there are any comments on this case, I should like to have them.

DR. ROBERT H. GROH: It seems to me that the progression of this woman's symptomatology, with papilledema in one eye and atrophy in the other, is typical of what is known as Foster Kennedy's syndrome, which is characteristic of a tumor of the frontal lobe. I should think that if she had had an injection of "thorotrast," some interested neurosurgeon must have attempted at that time to diagnose her original symptoms as indicative of a neoplasm. Foster Kennedy stated that certain tumors of the frontal lobe of the brain caused optic atrophy on the side of the tumor because of pressure cone and increased intracranial pressure caused choked disk on the opposite side. I would, therefore, be totally disinclined to regard the entire clinical picture in this case as due to an injection of "thorotrast" in the neck. Maybe "thorotrast" has worked up into the posterior nasopharynx, but everything need not be explained on the grounds of the use of this medium.

DR. THOMAS M. PEERY: I wonder if Dr. Klopp would comment on whether he thinks a neoplasm is present or not.

DR. KLOPP: It was our feeling that the destructive lesion in the base of the skull must be accounted for on the basis of some neoplasm and not on the basis of the injection of "thorotrast." The point which we brought up for discussion was whether this could be a neoplasm which is secondary to the presence of "thorotrast" over a long period. I believe a somewhat similar case was reported in which there was sarcoma in the spleen secondary to injection of "thorotrast."

DR. BLADES: We will leave this case, at least temporarily, and ask Dr. Peery to demonstrate microscopic sections from some of the cases which have been described.

DR. THOMAS PEERY: (Slide) This first slide is one prepared by Dr. Lindsay at Warwick Clinic from a cadaver in which thorium dioxide was injected into a muscle mass. There was no reaction of the tissue, since the injection was made in a dead body.

We are accustomed to seeing thorium in the liver and spleen, where it remains for a long time after it has been injected. (Slide) These are sections of liver and spleen. The hepatic cords are along in here, and the thorium is seen as these deposits clumped together along the perivascular spaces, replacing, apparently, parts of the hepatic parenchyma and, in the case of the spleen, some of the splenic pulp. In the liver it is characteristically collected in the Kupffer cells lining the sinusoids. In the spleen it is picked up by the large monocytes that are present everywhere in the pulp.

The other slides to be shown are from various cases, some of which have been discussed here. (Slide) The first one is from the collection made at the Walter Reed General Hospital. This is a Mallory stain. The thorium is present here in large deposits in big foamy mononuclear cells, comparable to the manner in which it is present in the liver and spleen in cases at autopsy.

DR. BLADES: Was this taken from the neck in a living subject?

DR. WILLIAM S. McCUNE: Yes, I think so.

DR. PEERY: The remaining slides are from consecutive biopsies in Dr. Klopp's case, and I believe they are of somewhat more interest.

53533

(Slide) This is material presumably from the nasopharynx, although there is no tissue by which to recognize it. There is no epithelial surface. There is an active inflammatory process, with extensive necrosis. Fibrin is deposited all through the tissue. That is material taken for the initial biopsy (fig. 4 *A* and *B*) and, if you recall, we do not know when the patient received thorium or whether she received it at all. Whatever she received, it is radiopaque, at least in the roentgenogram, and has radioactivity.

(Slide) This material, taken for a second biopsy (fig. 4 *C*), has a necrotic surface which may or may not be significant, but you will notice that there is considerable epithelial proliferation dipping down into the granulation tissue.

I would like to try to get a higher magnification of this one because it does show one other point of interest. The most significant change, I believe, in this more long-standing lesion is the tremendous proliferation of small blood vessels. Each of these small nests scattered through here, more or less rounded, is a small capillary, and it can be seen that they are greatly increased in number even if they cannot be recognized with certainty on the screen. Not only are these increased in number, but the lining cells are tremendously thickened. They represent pronounced hyperplasia of the endothelium of the small capillaries.

(Slide) Here is material from a still later biopsy (fig. 4 *D*), and you will note a change from the previous section in which the capillary and endothelial preparation is so pronounced. Here there are tremendous numbers of small vessels, but they are dilated and thin walled, comparable to those that develop in the skin and subcutaneous tissues after irradiation therapy. Changes such as these are to be found in the skin of the breast after irradiation or in the tissues of the abdominal wall after external irradiation has been given for cancer of the cervix. There is also considerable scarring here.

(Slide) The last slide I want to show you is again from Dr. Klopp's case, and this one has some areas that appear to me to be strongly suggestive of neoplasm. The cell type is suggestive of neurogenic sarcoma. It is certainly not an epithelial tumor.

DR. BLADES: Colonel Amory and Colonel Berman, of the Walter Reed General Hospital, have collected a rather large series of cases in which "thorotrast" has been used in the neck. Colonel Berman will present these cases and will tell us the conclusions which he and Colonel Amory have reached.

COLONEL HARRY L. BERMAN: I should like to preface these remarks by saying that the study on the perivascular injection of "thorotrast" and its sequelae was done by Colonel Amory and Dr. Bunch. I had nothing to do with the work, and my only relation to this matter is my appearance here to represent Colonel Amory and Colonel Bunch, both of whom are in Boston at the meeting of the Radiological Society of North America, where they are presenting this same paper. I will not cover the entire paper because part of it is related to a review of the literature, which I think would be redundant here.

A series of 7 cases of perivascular injection of "thorotrast" was recently studied at Walter Reed General Hospital, and the results of the study will appear in an early issue of *Radiology*. Perivascular injection of "thorotrast" in 6 of the cases resulted from attempted cerebral angiography and in the seventh from attempted injection into the brachial artery. In 1 case the injection was made directly into the exposed carotid artery, but in spite of this large amounts of "thorotrast" were found in the perivascular tissues.

In the first case which appeared the condition had been previously diagnosed as myositis ossificans because of the roentgenologic appearance. A history of an

injection of "thorotrast" could not be obtained in this case. The patient had severe pain in the right side of the neck, torticollis and marked dysphagia and dyspnea because of fibrous constriction of the trachea and esophagus. Examination revealed large, firm, tender masses in the right side of the neck, with fixation of



Fig. 4.—Photomicrographs of tissue removed from patient in figure 1. *A* and *B*, early reaction, showing increased vascularization, giant cells and round cell infiltration about granules of "thorotrast"; *C*, a later section showing increasing infiltration by lymphocytes and early fibrosis; *D*, advanced reaction, with dense fibrosis about foreign body granules.

soft tissue. The trachea was deviated to the right, and the esophagus was constricted to such an extent that the patient could swallow solid foods only by flexing her neck.

Roentgen examination showed that the "thorotrast" had extended down into the mediastinum and along the posterior pericardium almost to the diaphragm. Tissue removed at operation performed to free the esophagus and trachea was placed on a photographic film, and a radioautograph was obtained which proved the presence of radioactive material. The tissue from this and from a second case was analyzed at the Las Alamos Scientific Laboratory, Las Alamos, N. Mex., and found to be definitely alpha active. Spectrographic studies proved the presence of thorium in the tissues.

Three of the 7 patients have symptoms causing disability; in 2 these are definitely contributable to the presence of "thorotrast" in the soft tissues. Two patients have symptoms possibly due to the presence of "thorotrast," and 2 have no complaints. The patients who have been followed up for long periods have symptoms, whereas symptoms have not developed in those who have been followed for a shorter period.

It is known that "thorotrast" contains 20 per cent thorium dioxide by weight, and, compared with radium the radiation from 75 cc. equals 1.5 to 3 micrograms alpha activity, insignificant beta activity and 0.9 micrograms gamma activity. The ratio of tissue toxicity is alpha 10,000, beta 100, gamma 1.

It is believed that the patients who do not have symptoms will eventually have symptoms and perhaps disability as found in the others.

It was concluded that the prognosis in a case in which "thorotrast" is present in tissue should be guarded and that at no time is it justifiable to consider the highly ionizing alpha radiation from "thorotrast" in amounts now used as innocuous. The potential dangers accompanying the use of "thorotrast" far outweigh the slight advantage of the greater radiopacity, and its use as a contrast medium in clinical radiology should be discontinued.

DR. BLADES: The evidence seems to be accumulating that "thorotrast" is perhaps dangerous and certainly has significant radioactive properties. Dr. Gerwig has investigated this problem purely from the clinical standpoint and will probably have something to tell us.

DR. WALTER H. GERWIG JR.: Thorium is always accompanied with radiothorium. At present there is no known chemical method for separating thorium and radiothorium during the process of extracting and recovering thorium from monazite. The half life of thorium is 1.39×10^{10} years. We must consider that as degradation products are given off there is a fluctuation in radioactivity of the substance and as original radiothorium is dissipated to some extent there is a reaccumulation of new radiothorium. After a period of forty years the radioactive equilibrium is again restored in practically the same proportion as in the original substance. In other words, there is an undulation in intensity which may best be understood whenever one knows that some of the thorium changes to mesothorium and the alpha activity is decreased to some extent. Then mesothorium in turn will break down into radiothorium with increased alpha content. Therefore, it seems that there are alterations which strike an equilibrium over a period of about every forty years.

In this long-lived element, which for all intents and purposes may be considered to exist ad infinitum, we find another interesting feature. Thorium emits alpha, beta and gamma rays similar to those of the radium series. In radium therapy the alpha and beta particles are filtered out and it is the gamma rays which are responsible for therapeutic effects. In thorium the gamma and beta rays are rather insignificant, and it is to the alpha rays that we attach the greatest significance.

These alpha rays are ten thousand times as toxic as the gamma rays responsible for the therapeutic effects of radium.

To recapitulate, we have a drug whose life activity would project its dissipation into millions of years in the future and which emanates alpha particles of extreme toxicity. Even though there is an undulation in its effect, there are periodic intervals during its life activity when original radioactive equilibrium is restored. On account of these factors, I think that we are dealing with an extremely dangerous substance.

DR. BLADES: Of course, an important point to consider in a discussion of this drug is its distribution in the body. Dr. Gerber!

DR. LEON GERBER: I should like to summarize briefly its distribution in the body. In the first place, according to Yater, about 75 cc. of thorium solution is used in the average case. That follows a pattern of about 0.5 cc. per pound of body weight. This is the amount necessary to obtain an adequate hepatosplenogram. The solution has been absorbed in the bloodstream within fifteen minutes of the time of its successful injection. It is then distributed to the elements of the reticuloendothelial system, mainly to the liver and spleen, the lymph nodes and the bone marrow.

One can, as has been indicated, trace this with a Geiger counter and, in the case of the spleen and liver, by roentgen examination. As far as we are able to tell, the substance remains in situ indefinitely. Only a small proportion, the exact amount of which is evidently not determined, is excreted by the kidneys.

DR. BLADES: Dr. Pearl Holly has a real and active interest in radiopaque materials and has had the advantage of association with various members of the Carnegie Geophysical Laboratory. Perhaps Dr. Holly will make some remarks about the pure physics of this substance.

DR. PEARL B. HOLLY: I have, rather, a few remarks to make about the hematologic effects of this substance, and then I shall quote Dr. Urry's remarks about its radioactive assay.

About two and a half years ago we had a case of aplastic anemia in a 53 year old Negro woman; she died about five days after her admission to the hospital. Microscopic examination revealed thorium dioxide deposited in the liver and spleen. She had not given us a history of a previous admission to the hospital. After the autopsy findings were reported, we examined the hospital records and found that she had been admitted ten years previously because of abdominal pain. At that time cirrhosis of the liver was suspected, and she had received thorium dioxide intravenously (presumably about 75 cc.).

Physical examination on this last admission, in 1944, revealed two nodules on both antecubital fossas which were about 3 cm. in diameter, firm, freely movable and not attached to the underlying or overlying tissues.

A portable roentgenogram was taken on her third day in the hospital. It was reported to reveal a small contracted spleen, and, as you can see here, there was an accessory spleen. This report was put on the chart after death, and the significance of the visualized spleen was overlooked. This was verified at the postmortem examination. The spleen weighed 15 Gm. and was small and contracted and on microscopic section thorium dioxide was found in the spleen, liver and bone marrow.

We sent specimens of tissue to Dr. William D. Urry at the Geophysical Laboratory at Carnegie Institute, who assayed their radioactivity. He reported that

the amount of radioactivity which was there would, when present internally in the body in constant irradiation, produce tissue damage such as that which was present. The bone marrow was markedly hypoplastic. This case was reported by J. Spier and others in the *Journal of Laboratory and Clinical Medicine* (32:147, 1947).

Previous reports of "thorotrast" affecting the hematopoietic system have not been numerous, though more might be expected from the numbers who have received this material. Evidently, the so-called resistance of the host is important, and different persons react in different fashion.

Dr. Klopp referred to the case of sarcoma of the liver which was reported by McMann and Murphy in the *Archives of Pathology* two or three months ago. In their case sarcoma of the liver was found near the area of greatest concentration of "thorotrast." Their patient had received the preparation twelve years previously. She had not been in the hospital long enough for a hematologic study but came in and died in the admitting office. Her bone marrow was hypoplastic.

Dr. Urry's reports of radioactivity are similar to those of the Las Alamos group in that most of the activity was due to the alpha particles. Alpha particles ordinarily do not cause trouble when administered externally because they do not penetrate the tissues; nevertheless, when implanted in the body, they are a constant source of irradiation and therefore produce the same effect as the gamma rays.

DR. BLADES: Dr. Groh just made a remark to me that he felt like Little Red Riding Hood among a pack of wolves, which is synonymous with saying that he is a lone neurologist among a group of surgeons. We will now ask him to defend himself.

DR. ROBERT H. GROH: The neurologist in many ways has been a "guesser," for he is faced many times with the problem of deciding whether a person suffering from intracranial disease should or should not undergo the rather extensive operative procedures involved in neurosurgical treatment. By means of the carotid arteriogram, we are frequently able to make the decision, since often types of intracranial tumors can be diagnosed preoperatively in this way. The vascular pattern that is seen is an indication of whether the tumor is a glioblastoma, a meningioma, an astrocytoma or some other type of tumor that has a particular vascular pattern. The neurologist frequently needs the information obtained from a carotid arteriogram.

Many times the diagnosis of intracranial disease can be made more accurately by this means than by an air encephalogram. We have used "thorotrast" since its introduction when attempting to gain this knowledge. It is true that in the first several years of experience with it the patients occasionally had "thorotrast" injected into the neck while a carotid arteriogram was being made. If the technic is performed accurately, this need not occur in the direct puncture of the carotid artery. It is a procedure that requires a certain amount of experience and skill, but this is not difficult to acquire. I do feel that "thorotrast" need not be injected into the perivascular tissues of the neck.

When faced with serious neurologic disease, I wonder whether it makes any difference if a patient has "thorotrast" in his liver and spleen for fifteen years. Does this matter, if we are able to get information of diagnostic value to tell the patient or his family or both about his intracranial disease?

There are several iodine preparations that have been used in arteriography of all parts of the body, and particularly the head. Use of these requires an open incision

in the neck and an exposure of the carotid artery because the highly concentrated, sclerosing substances of the iodine type can produce their own damage in the neck if they are injected extravascularly.

We have attempted to avoid this exposure as much as possible. Whether the results at this clinic warrant a revision of our thinking remains to be seen. Certainly, one cannot deny the facts that have been presented here today in reference to "thorotrast." Whether or not it is necessary in some instances to have the highly definitive picture that "thorotrast" can give as compared with the iodine preparations is a problem that only the neurologist and the neurosurgeon can answer. Our idea now is that if the diagnosis of malignant glioblastoma can be made the patient should not undergo extensive neurosurgical treatment. How can this diagnosis be made without a procedure as accurate as arteriography?

The technic which is essential in giving an accurate intracarotid arterial injection without thorotrast being spilled in the neck requires a needle, a three way stopcock, a 20 cc. syringe and on the side arm of the stopcock a piece of rubber tubing with a smaller, maybe a 10 cc., syringe.

The puncture into the artery is made with the needle, with the stopcock so turned that the force of blood will come back into the empty syringe. The 20 cc. syringe contains the "thorotrast." When we get blood under pressure into the empty syringe, we force it back in, holding the needle in place. If a mass forms in the neck, the needle is not fully in the artery, and 2 or 3 cc. will produce a swelling along the carotid sheath. This mass can be felt and seen. The blood can be reinjected. We let it come back again and force it in a second time, and if then there is still no swelling in the neck, we presume that the needle is in the carotid artery. So long as the needle does not move while the stopcock is being turned, it seems to me that the intra-arterial injection of the "thorotrast" can be accomplished without any difficulty.

DR. BLADES: Dr. Groh, you have done a splendid job of holding the wolves at bay, at least temporarily. Apparently these accidents with "thorotrast" are not new. They have been known. We have simply had the good fortune of seeing a number of cases lately. Dr. Iovine has reviewed the literature concerning the history of "thorotrast" and may have something to add in that respect.

DR. VINCENT IOVINE: Thorium itself was discovered by Berzelius in 1819. There is little else in the literature, from a medical point of view, until about 1907, when a pharmacologist named Sollman investigated its properties in various animal experiments. About the same time, a physiochemist named Hahn discovered mesothorium, one of the radioactive components that is under discussion today. In 1912 numerous German investigators attempted further clinical investigation using animals.

It is interesting to note that in 1915 a resident urologist at Johns Hopkins Hospital (Burns), who was searching for a more radiopaque substance for outlining anomalies of the genitourinary tract, used thorium itself in combination with other salts and outlined the genitourinary tract in some 200 cases without subsequent complication.

The first use of thorium dioxide, I believe, was instituted by two workers in their separate fields. Oka, a Japanese, found, when he was experimenting with thorium dioxide, that some roentgenograms of rabbits into which the substance had been injected outlined the spleen and liver. He apparently failed to interpret the results from a radiologic point of view. In the same year, 1928, a German in Berlin named Paul Radt, working at the Pathological Institute, used thorium

dioxide to outline the liver and spleen in animals and correctly inferred that the outline was the result of the affinity of thorium dioxide for the reticuloendothelial system. In the same year he first used the substance to outline the liver and spleen in human subjects. This investigator at first applied his discovery to the outlining of foreign bodies in the spleen or liver in animals, and he deduced that probably the substance could be used to outline tumors, other types of new growth or more pathologic variations in the liver and spleen.

In this country, as you know, Dr. Yater started using thorium dioxide for hepatosplenograms in 1933 and, I believe, in 1943 reported its use in several hundred cases.

It is also interesting to note that in the thirties there were numerous articles in the German literature referring to the carcinogenic properties of thorium dioxide in animals, and there are frequent articles referring to granulomatous processes appearing in the body when the substance was infiltrated into the tissues in an extravascular manner.

DR. BLADES: Dr. Iovine has mentioned Dr. Yater's work, and I am sure all of you know Dr. Yater. During the period of his pioneer work, Dr. Weinstein was a resident in this hospital. Have you some remarks about Dr. Yater's early experience?

DR. J. J. WEINSTEIN: One of the first reports in 1933 described his technic for using this dye as a diagnostic procedure for lesions in the liver and the spleen. He at that time listed some twelve or thirteen indications for the use of "thorotrast" as a diagnostic medium. He used it in the diagnosis of carcinoma of the liver, hepatic abscesses or lesions above the liver, lesions below the liver, unknown palpable masses, cirrhosis and other types of hepatic disease and jaundice and for the determination of certain primary diseases in the spleen.

In his later reports he changed his procedure somewhat as he began to investigate more carefully. About 1936 he rather limited his use of the material to the diagnosis of tumor masses primarily in the liver, and he had found that his roentgenograms of the spleen were not too diagnostic as far as primary disease was concerned. He could visualize mainly size and not so much metastasis or changes within the spleen itself. Since that time, in still further reports, he has limited his scope of diagnosis primarily to hepatic abscesses, cysts in the liver and metastatic lesions.

He uses the drug chiefly in instances in which it is of serious importance to diagnose abscesses, especially those of amebic origin, and secondly when there may be primary tumors of the liver or a metastatic carcinomatous lesion that is not recognized clinically before surgical intervention. The diagnosis of such lesions beforehand would certainly help in the care of the patients. As Dr. Groh has pointed out, it is an important diagnostic measure when it is necessary to eliminate certain types of surgical procedures.

DR. BLADES: Since this technic of diagnosis is so important, it would be of interest to explore the possibilities of agents which might be satisfactory and perhaps less dangerous. Dr. Harrell!

DR. J. BLAINE HARRELL: During the past decade, angiography has become an important and widely used diagnostic procedure. Two types of radiopaque solutions are used in this community. These are (1) "thorotrast" and (2) "diodrast," an iodine-containing preparation.

"Thorotrast" is preferred because it gives sharp contrast and shows fine detail. Its potential dangers have been emphasized during this session. However, many, particularly those who study cerebral angiograms, believe that the advantages

of "thorotrast" justify the hazards. Actually, each of the granulomas discussed here was caused by a preventable technical error. Practice and improved skill should reduce such occurrences. I have recently observed Dr. Groh make an injection into a carotid artery. His precautions would seem to make perivascular infiltration impossible.

"Diodrast" renders contrast which is entirely adequate for angiocardiograms and for studies of the vessels of the extremities. It has the distinct advantage of being rapidly excreted. Thus its use can be repeated, which permits the taking of views from different angles and allows progress studies to be made. Escape of "diodrast" into perivascular tissues seldom causes more than a mild inflammatory reaction.

DR. BLADES: From the standpoint of the surgeons, the primary problem concerning the patients whom we have seen today is: Can we do anything for them surgically, and, if we can, what is the surgical objective? I believe Dr. Richtmeyer has explored the possibilities of surgical excision in the type of case described.

DR. DUANE C. RICHTMEYER: Since "thorotrast" is a radioactive substance and eventually causes fibrous tumors when it is placed outside of the blood vessels in tissue, I believe that it should be removed from those places into which it has been extravasated, although usually this will necessitate a block dissection of the area involved.

DR. BLADES: We have seen today 3 patients in whom "thorotrast" has accidentally been injected into the tissues of the neck. On our own service here we have 4 cases in which this occurred. These with Dr. Bradley's case and the Walter Reed series make a total of 13 cases in which thorotrast has caused untoward results. In 11 instances the material has been injected into the neck and in 2 into the antecubital fossa.

ORTHOPEDIC SURGERY IN THE ARMY AIR FORCES DURING WORLD WAR II

III. Psychologic Problems, Convalescent Care and Rehabilitation

J. VERNON LUCK, M.D.
LOS ANGELES

HUGH M. A. SMITH, M.D.
MEMPHIS, TENN.

HENRY B. LACEY, M.D.
COLUMBUS, OHIO
AND

A. R. SHANDS Jr., M.D.
WILMINGTON, DEL.

PSYCHOLOGIC PROBLEMS

THROUGHOUT World War II, it was repeatedly urged that all medical officers learn psychiatric principles. Menninger¹ stated: ". . . whether a medical officer is a battalion surgeon, or an orthopedist in a hospital, a dispensary physician or an induction board examiner, he will have numerous occasions when he must exercise psychiatric judgment. Probably more truly than in civilian life, every medical officer is faced with personality deviations." Military orthopedic surgeons soon came to realize there was no alternative to learning more about the psychiatric aspect of orthopedic problems. A steady stream of patients presenting psychogenic musculoskeletal symptoms was referred to orthopedic sections. In the beginning, the disability in

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1. Menninger, W. C.: Opportunities for Treatment of Neuropsychiatric Patients, Bull. U. S. Army M. Dept., March 1944, no. 74, p. 90.

many of these patients was labeled organic, and they were given long periods of hospitalization and intensive orthopedic therapy, which occasionally included surgical treatment. Gradually the true character of the disability in these patients was discovered. As time passed and experience widened, general practitioners and orthopedists learned of more proper evaluation, treatment and disposition. Such things as personality structure, emotional maturity and neurotic reactions came to have new meaning. A few medical officers were carried away by the psychosomatic approach and erroneously saw a psychogenic basis for some clearly organic diseases. After considerable groping and study, most military orthopedists expressed the belief that they had found the middle of the road. Many stated the opinion that for the first time in their professional careers they were systematically treating patients with orthopedic disability in their entirety, as human beings, and not merely as animated skeletons. Orthopedic surgeons, as well as all other clinical specialists, were stirred to the realization that the psychiatric aspect of their specialty could no longer be ignored or dealt with only by intuition.

How frequently were symptom-producing psychologic problems encountered on an orthopedic service? A survey of all patients hospitalized on one large orthopedic service² for a period of one year disclosed that 11.1 per cent had psychologic problems which were either the sole cause or the most important contributing cause of the musculoskeletal symptoms necessitating hospitalization. Among the orthopedic outpatients of that same orthopedic service during that same year, the disability in 25 per cent was predominantly psychogenic.

In a study on the medical service of an army general hospital (Hoff) Boland and Corr³ observed that of 450 consecutive cases in which the diagnosis was arthritis or an allied organic condition, "psychogenic rheumatism" was the most frequent cause of disability. At another army general hospital (Tilton) Saxe⁴ reported that "functional muscular disability comprises over 50 per cent of cases admitted to this hospital as organic neurologic disease. The most common entities for which this psychogenic manifestation is mistaken are spinal cord tumor, herniated intervertebral disk, peripheral neuritis, brain tumor, and degenerative diseases such as multiple sclerosis and syringomyelia."

2. Luck, J. V.: Psychosomatic Problems in Military Orthopaedic Surgery, *J. Bone & Joint Surg.* **28**:213, 1946.

3. Boland, E. W., and Corr, W. P.: Psychogenic Rheumatism, *J. A. M. A.* **123**:805 (Nov. 27) 1943.

4. Saxe, E.: Functional Muscular Disabilities: Their Recognition and Treatment, *Bull. Menninger Clin.* **8**:59, 1944.

Based on relationship to an organic lesion, three types of psychogenic cases were seen on the Army Air Forces orthopedic services: (1) those in which no relevant organic lesion could be uncovered, either in the past or present. (2) those in which psychogenic problems were secondary to organic lesions and (3) those in which psychogenic problems perpetuated some of the physical symptoms of a healed organic lesion. From a psychiatric standpoint the disabilities were divided into: (1) conversion reactions, (2) anxiety or tension states and (3) elaborations (psychogenic elaboration of symptoms from an organic musculoskeletal lesion). Various combinations of these types were commoner than pure types.

This report is based on detailed observations of more than 1,000 cases in which the psychogenic factor was the cause of musculoskeletal symptoms. Most of the patients were not confirmed psychoneurotic persons. The disability in many was classified by the psychiatrists as simple adult maladjustment, meaning, in most instances, that the patient had remained adjusted emotionally for most of his life but had succumbed to what had been to him overwhelming physical stresses, usually incident to military service. To see such large numbers of these cases was a new experience both to psychiatrists and orthopedists. As Murray⁵ pointed out, "The short span of time in which individuals go from health to neuroses and back to a reasonably healthy state again is completely foreign to civilian experience."

Psychologic History.—On many orthopedic services, an abbreviated psychologic history was taken in all cases in which the source of symptoms was obscure and when inadequate objective and laboratory evidence existed to explain the subjective symptoms. The long comprehensive history taken by psychiatrists requires considerable time to take and much experience to interpret; such a study is essential only for the understanding and evaluation in complex cases. An abbreviated psychologic history can be taken readily by any physician, along with the regular clinical history. After such a study a psychologic disorder will not often be perpetuated by being diagnosed and treated as an organic entity or, just as bad, denied all treatment because no organic lesion is identified. Menninger⁶ outlined an abbreviated neuropsychiatric examination. Army Air Forces flight surgeons employed a similar survey. These examinations included a series of questions to bring out the patient's adjustment to life in general, to the Army, and to his occupation, his school, his family and his friends. The degree of emotional maturity (personality structure) was ascertained and a basis secured on

5. Murray, J. M.: Psychiatric Evaluation of Those Returning from Combat, *J. A. M. A.* **126**:148 (Sept. 16) 1944.

6. Menninger, W. C.: A Condensed Neuropsychiatric Examination for Use by Selective Service Boards, *War Med.* **1**:843 (Nov.) 1941.

which the patient's ability to make future adjustments could be evaluated. General intelligence of the patient was estimated, as was also the character (organic or psychogenic) of past and present somatic symptoms. The questions pertaining to family history included questions to bring out the presence of psychologic problems in members of the patient's family. An evaluation of the soldier's motivation and morale was essential. The capacity of poor motivation and low morale to precipitate psychologic problems was impressive, but not any more impressive than the ability of proper motivation and high morale to cure and to prevent psychosomatic symptoms. Gordon⁷ stated, "More people are sick because they are unhappy than unhappy because they are sick." Many were the factors in military life during the war which caused resentment, hostility and anxiety in emotionally immature persons. Growing anxiety often resulted in neurotic physical symptoms. Soldiers with poor physical resistance did not await combat conditions to present a neurotic reaction, but often presented a psychosomatic problem in the first few months of service. These soldiers could not withstand regimentation and steady hard monotonous work, plus the denial of home life, luxuries and old friends. Their despair and resentment gave rise to frustration and conflicts, which ushered in mental depression and disturbed sleep. Sleeplessness plus long hours of hard work led to chronic fatigue, more insomnia and more anxiety. The soldier then frequently met an adverse situation that was "the straw that broke the camel's back" and dramatically converted his emotional chaos into physical symptoms, which, when manifested in the musculoskeletal system, often led to hospitalization on an orthopedic service. Such soldiers had a low threshold of conversion.

Analysis of Psychogenic Musculoskeletal Pains.—A clue to the functional origin of psychogenic musculoskeletal pain frequently came from coaxing the neurotic person to describe his pains accurately. At the outset he usually described his physical distress as being simply a pain, just as did the patient with an organic lesion. On further questioning, the so-called pain was often found to be a feeling of tightness or of pressure or there was a localized area of intense fatigue or a "dead" feeling. Extremities were described as feeling numb or asleep or as though one or more of them were missing. There was no position of complete relief, and immobilization often aggravated the distress. Bizarre patterns of radiating pain also characterized many neuroses. One of the most frequent psychogenic radiations went from the coccyx or sacral region to the upper part of the back or the occiput. Pain radiating from a distal point proximally was more often of functional origin than pain which radiated distalward.

7. Gordon, A.: Modern Conception of Neuroses, J. Nat. M. A. 36:121, 1944.

Sites of Neurotic Musculoskeletal Symptoms: While no parts of the musculoskeletal system were observed to be exempt, there were certain sites which were particularly susceptible to becoming foci of neurotic symptoms. These favored sites were the sacrum, coccyx, knees, feet, neck and shoulders. The site of a healed fracture or operative scar not infrequently was the somatic focus into which the neurotic person channeled the expression of his emotional stresses.

Although in some instances it was impossible to uncover an explanation of the particular site at which symptoms occurred, in a high percentage of patients combined orthopedic and psychologic histories identified the focus of neurotic symptoms as being the site of previous organic symptoms either in the patient himself or in some one close to him, i. e., his mother, father or brother.

Objective Observations in the Neuroses: In some instances the physical examination revealed no positive observations, and in others it disclosed many. The more frequent objective observations were: (1) circumferential hypalgesia (better known as stocking and glove anesthesia), (2) hysterical paralysis, (3) vasomotor instability, (4) hyperhidrosis, (5) hyperactive reflexes, (6) camptocormia (forward bend of the spine), (7) astasia abasia (able to sit and to move about well in bed but unable to stand or walk) and (8) coarse intention tremor of an extremity. It must be emphasized that a clinical picture was not considered to be psychogenic on the basis of any solitary symptom, but only after weighing all objective and subjective observations.

Circumferential Hypalgesia: One of the most significant objective evidences of a neurosis, and one of the most frequently overlooked, was the presence of nonanatomic areas of diminished sensation. Although conversion hysteria rarely produced anesthesia and analgesia, it frequently was associated with production of hypalgesia. There usually was a diminished response to heat and cold as well as touch and pain, but no test was so satisfactory for identifying the levels of diminished sensation as the pinprick test for pain. When there was hysterical hypalgesia of overlying skin, there was similar hypalgesia of such deep structures as the periosteum and synovia. In testing sensation, every precaution was taken to avoid suggesting a response to the patient.

One hundred consecutive patterns of circumferential hypalgesia were recorded on the sketches by Luck.² This series portrayed the wide variation in the patterns and also the high proportion of patients with multiple sites of involvement. Of the 100 patients, 90 showed multiple sites of nonanatomic hypalgesia, 72 having some degree of involvement of all four extremities. Changes were confined to the right side of the body in 11 patients and to the left in 4. In 52 patients part or all of the head was involved. The site of subjective symptoms frequently

appeared unrelated to the pattern of hypalgesia. Hysterical paralysis was present in 9 of the patients and in all instances was confined to one of the extremities.

Psychosomatic Backache: Psychogenic back pain was observed to be (1) a part of a conversion reaction, (2) the result of nervous tension in an anxiety state or (3) an elaboration of organic symptoms of the back. Although various combinations of these types were commoner than pure types, one factor usually stood out above the others. In the analysis of consecutive cases of psychogenic pain in the back, the condition in approximately one third proved to be the result of anxiety states, in one third it was a symptom of a conversion reaction and in a third it was an elaboration of organic symptoms of the back. The patients with tension states had pain at one or more tension or fatigue points in the spine (lumbosacral junction, middorsal region and upper cervical and occipital regions). Pain in the conversion reactions was widespread and generally associated with pain radiating from the coccyx to the neck and also with circumferential hypalgesia. Camptocormia was present in 3 of the patients with conversion reactions. The elaboration symptoms represented actual exaggeration of the existing organic symptoms or superimposed conversion and tension symptoms. A lumbosacral lesion was the most frequently associated organic impairment.

Treatment and Disposition: The psychiatrists took over the complex psychologic problems, but for a large group of patients, particularly those with combined psychogenic and organic musculoskeletal symptoms, the orthopedists had to assume the responsibility for the psychotherapy. Just as there was an acceptable abbreviated psychologic history, there was worth while abbreviated psychotherapy—usually referred to as superficial or minor psychotherapy. It included: (1) evaluation and advice regarding the correction of environmental conflicts, (2) the giving of insight into the character of the existing psychologic symptoms, together with an explanation of coexisting organic symptoms, (3) identification and elimination of the underlying conflict when possible and, when this was not possible, the elimination of aggravating factors, (4) the administration of sedatives when there were insomnia and chronic fatigue and (5) the prescription of occupational therapy when indicated. Insight was not given until the patient's confidence was secured—as the psychiatrists said, “until rapport was established.”

Some soldiers experienced functional symptoms only under the most profound and prolonged mental and physical stresses. In such men the response to treatment and the prognosis were much better than in persons in whom neurotic episodes developed during ordinary stresses of life.

During treatment for organic lesions every effort was made to detect and correct bad psychologic trends and incipient neurotic reactions. In general the earlier the neurotic symptoms were treated, the better the response and prognosis.

Prior to elective surgical treatment, patients were carefully evaluated psychologically. This procedure proved to be eminently worth while. As Wechsler⁸ has said in referring to unwarranted surgical treatment of neurotic persons, "Heroic operations do violence to patients and confirm their neurosis."

Soldiers with neurotic musculoskeletal symptoms were urged to carry on and were firmly informed that their work would do their musculoskeletal system no harm—rather the giving in to every symptom was one of the real sources of harm.

Giving intensive mechanistic therapy for neurotic musculoskeletal symptoms proved to be harmful and often fixed and perpetuated the symptoms. Halliday⁹ emphasized that, "With increased facilities for mechanistic diagnosis and therapy, there is danger, if relevant considerations are omitted, of inducing 'fixation invalidism' on a scale hitherto unknown." This error was made all too frequently. In large numbers of soldiers with neurotic musculoskeletal symptoms, physical therapy procedures were carried out almost endlessly. On several orthopedic services, where psychosomatic problems were not properly differentiated from organic problems, numerous patients were seen who had received protracted periods of hospitalization with such diagnoses as lumbosacral and sacroiliac strains, traumatic osteoarthritis, synovitis and sprains. A wide variety of orthopedic procedures were carried out in these patients, including surgical treatment. During the latter part of the war, a wider understanding of psychosomatic problems was apparent in the greatly reduced number of psychologic problems labeled with musculoskeletal diagnoses.

ORTHOPEDIC CONVALESCENT CARE AND REHABILITATION

Medical care in World War II, with its emphasis on improved convalescent care and rehabilitation, showed great advancement. Each branch of the service, beginning with the Army Air Forces, developed an extensive and far reaching convalescent rehabilitation program. Orthopedic convalescent care and rehabilitation were a large and important part of these programs. The high plane of the present concept of this aspect of orthopedic surgery is due in no small degree to knowledge gained during the war.

8. Wechsler, I. S.: *A Textbook of Clinical Neurology*, ed. 5, Philadelphia, W. B. Saunders Company, 1943.

9. Halliday, J. L.: *The Rising Incidence of Psychosomatic Illness*, Brit. M. J. 2:11, 1938.

Previous to the war, with the exception of scattered small groups of workers, it was the accepted policy during immobilization of extremities or the spine to allow atrophy of muscles and stiffness in joints to proceed unchecked. At the end of the period of immobilization the patient, with his flabby muscles and stiff joints, was given physical therapy, usually for many weeks, which consisted of baking and massage plus passive stretching of the joints.

In orthopedic rehabilitation, as it is now practiced, the muscles are contracted actively from the outset, regardless of the type of immobilization, and when the period of immobilization ends, vigorous resisted active joint motion replaces passive stretching. It was discovered that if proper care was given to the muscles, the joints took care of themselves.

Orthopedic rehabilitation proved to be much more than the giving of systematic resisted exercises; it also required treating the patient psychologically. Sources of anxiety were legion, but many were anxieties anticipated and relieved before they created a disabling burden of nervous tension.

The fundamental aspects of orthopedic rehabilitation are: (1) repetition, (2) resistance, (3) reassurance and (4) sequence of exercises, the power stage, the mobility stage and the coordination stage.

Repetition.—In the preservation or restoration of musculoarticular function, nothing proved to be more fundamental than the frequent repetition of exercises. Elaborate heating apparatuses, whirling water and massage had their place, but they did not build strong muscles. At the outset, the patient was made to understand that rehabilitation could come to him only by his own efforts; rehabilitation cannot be "spoon fed."

On most of the orthopedic services a program of active exercise was instituted the first day following an operation or a fracture. Waiting several days or "until the stitches are out" generally was discovered to be a mistake. In the case of elective surgical treatment, the detailed instructions and demonstrations of the postoperative exercise routine were presented to the patient preoperatively.

Notwithstanding widespread impressions to the contrary, it was learned that exercises can be carried out effectively and systematically inside the largest plaster of paris cast or in the most complex traction. Good circulation was maintained, healing stimulated and stiffness of joints, atrophy of muscles and impaired coordination reduced to a minimum. Patients were informed that each muscle group must be forcefully contracted and exercised, just as though the joints were free to move. Instructions were given regarding the location and function of the various impaired muscle groups, so that the soldier could systematically exercise each group in turn. For example, with a foot and

leg encased in plaster of paris, the foot was plantar flexed, dorsiflexed, inverted and everted with progressively increased firmness against the inside surface of the cast. The cast had to fit sufficiently snugly to prevent unwanted mobility of fracture fragments and joints. If a cast became loose, the space between the cast and skin was packed, and if this was not feasible a new cast was applied.

The question often arose as to whether exercises should be carried out for thirty minutes once a day or for "five minutes every daylight hour." In most instances a combination of these two methods of exercise was found to have much to recommend it. A widely employed routine consisted of a ten to thirty minute period of vigorous effort and instruction once a day, supplemented by a five minute period of exercise every daylight hour. In late stages of convalescence, when most of the exercises were carried out in a gymnasium and in the occupational therapy department, the exercise period every hour was not so essential.

One of the finest of the several rewards that came to the patient for the frequent repetition of exercise routines during orthopedic convalescence was the prevention of impaired coordination. Immobilization without exercise (passive immobilization) resulted not only in atrophy of muscles and stiffness of the joints but also in damage to the patient's ability to coordinate the movements of the immobilized joints. Highly skilled movements were the first to go, but, with longer periods of passive immobilization, even such fundamental unconditioned reflexes as the cylindric grasp frequently became so impaired as to suggest paralysis.¹⁰ Through many painful experiences it was learned that loss of coordination was infinitely easier to prevent than to restore.

Resistance.—The second fundamental in orthopedic rehabilitation proved to be that exercises must be carried out against progressively increasing resistance. Muscles increase in strength in direct proportion to the demands placed on them, so that in retaining or regaining muscle strength it was imperative that the muscles be given an increasingly heavy load. It is a well known law of nature that increased demand and function of a part of the body bring increased capacity for work, and, conversely, when function ceases the capacity to function steadily diminishes and ultimately may be lost.

Resistance to muscle contraction was supplied in a multitude of ways. The simplest of all methods was the use of agonist against antagonist. Since muscles of locomotion are paired, one balancing the action of the other, it was possible to exercise one muscle against its opposite. This form of exercise involved no appreciable movement of the joints, making it an excellent resistance technic for muscles inside casts and in certain types of traction. After practice, patients learned

¹⁰ Nicoll, E. A.: Rehabilitation of the Injured, Brit. M. J. 1:501, 1941.

that strong resistance could be supplied to the muscle contractions; the fatigue following periods of this form of exercise was testimony to the energy expended. Watson-Jones¹¹ pointed out that Sandow, once the world's strongest man, utilized this method to attain his great strength. Elaborate apparatus was not always available, but, fortunately, was not essential for carrying out resisted exercises; the only essentials were bags of weights, rope and pulleys, a knowledge of anatomic structure and a passion for preaching "the gospel of rehabilitation."¹² The weight of the body itself frequently served as the source of resistance, e. g., in deep knee bends, push-ups and pull-ups.

There does not appear to be nearly so much danger of damaging weak muscles by overloading them as orthopedic surgeons had been taught to believe. Now, after the broad war experience in systematically employing heavy resistance exercises, it can be said with confidence that this is the most effective and the most rapid method of restoring weak atrophied muscles to their normal dimensions and strength. No harm was observed from pushing a weak muscle to do its utmost against all of the resistance against which it could move. If there were minute hemorrhages and ruptured muscle fibers, they did not assert themselves in any conspicuous manner. During heavily resisted contractions and relaxations, care was taken to prevent jerking, contractions being made smoothly and slowly. Heavy weights were built up to gradually, and complete relaxation between lifts was emphasized.

Minimal resistance free-swinging exercises had a place, but only after muscles were sufficiently strong to protect the joints from the strains and sprains that were so liable to occur from excessive joint motion when muscles were weak.

A convenient and effective source of resistance for bed exercises proved to be the stretcher made either with springs or elastic rope. When springs were not available, strands of elastic rope were stretched between a pair of handles. Such home-made stretchers were cheap enough for each bed patient to have his own to exercise all free extremities and his neck.

When skeletal muscles were not exercised during periods of immobilization, circulatory changes occurred in the immobilized joints, which frequently led to permanent damage. Joints that became stiff during immobilization did so more because of circulatory impairment than because of lack of joint movement. There is a "pumping action"¹³ from

11. Watson-Jones, R.: *Fractures and Joint Injuries*, ed. 3, Baltimore, Williams & Wilkins Company, 1944.

12. Rusk, H. A.: *The Army Air Forces' Convalescent-Rehabilitation Training Program (First Year's Experience)*, J. Indiana M. A. **36**:649, 1943.

13. Griffiths, H. E.: *Treatment of the Injured Workman*, *Lancet* **1**:15, 1943.

muscle contractions in that during contraction the veins are compressed and the blood pressed proximally on its way to the heart. Bainbridge (1931)¹⁴ demonstrated experimentally that the quantity of blood circulating through a muscle increases four to nine times during exercise. During passive immobilization the venous stasis developing in the encased joints may ultimately lead to an edematous, inflexible joint capsule, fibrin extravasation, atrophy of the articular cartilage and adhesions.

Reassurance.—There was a steadily increasing appreciation and understanding of this phase of rehabilitation throughout the war. Imparting reassurance, it was soon learned, required something more than giving the soldier a pat on the back. Orthopedists were stirred to the realization of the tremendously important psychologic aspect to orthopedic rehabilitation. Whereas, most orthopedists formerly depended almost entirely on their intuition, they learned during the war to employ a scientific and systematic approach, because of the efforts of the psychiatrists.

Insight into their medical problems was reassuring to most patients. When the diagnosis, treatment and prognosis were shrouded in mystery, the patient had innumerable anxious hours. When soldiers understood why they were required to carry out laborious and monotonous routines, they were far more willing to cooperate and were far less likely to present a psychological problem.

No substitute was found for daily personal contact with the patient; a friendly patient-physician relationship was indispensable. One source of stimulation for both patient and physician was in the keeping of good records in the form of graphs, in which the strength, circumference and joint motion of extremities were plotted. Patients would strive earnestly to keep their graphs on the upswing.

Arranging patients with similar orthopedic problems together and establishing a spirit of rivalry went far in building morale and minimizing boredom. Every effort was made to create a spirit of optimism and good cheer in the wards. When weather permitted, outside activities were encouraged, and they did much to inspire and reassure.

Bad psychological trends and lapses of morale were easier to prevent than to correct. A strenuous effort was made to veer soldiers away from regarding themselves as invalids; this was accomplished in part by treating them as "wounded athletes," and not as sick patients. The secondary gains from illness were often considerable, and it was necessary to keep in mind that there is a human tendency to drift toward the security of being dependent on others.

14. Bainbridge, cited by Griffiths.¹³

During ward rounds each patient's morale was checked along with the orthopedic examination. If there was a lapse in morale, something was generally done about it. When there were family or financial problems, and this was common, the Red Cross often was turned to for valuable assistance.

When the prognosis appeared bad, it was learned by bitter experience that it should not be discussed with the patient until it was ascertained that it truly was bad, and even then such a prognosis needed to be presented tactfully and in an optimistic light. For example, there were many instances in which much harm was done by telling a patient with a serious injury of the joint that arthritis would develop in the joint. When the word "arthritis" was used at all, orthopedists learned that they should quickly point out that it would not be the destructive arthritis (rheumatoid) familiar to the laity. Innumerable patients with traumatic arthritis were encountered who were in constant anxiety for fear that at any time the "arthritis" would spread from joint to joint and make them invalids. Such anxiety in a "bread winner," already partly incapacitated, was observed frequently enough to precipitate neurotic symptoms. Many disabling neurotic reactions on this basis could have been prevented.

Sequence of Exercises.—In the process of becoming rehabilitated, most patients passed through three stages: the first, the power stage, with its emphasis on building up muscle strength; the second, the mobility stage, in which maximum effort was directed toward restoring a full range of joint motion, and, third, the coordination stage, in which muscles and joints were helped to function with precision.

Obviously there was considerable overlapping in these stages, but it proved helpful to speak in terms of stages in order to emphasize the steps the patient must take in climbing the ladder of rehabilitation.

Power Stage: Often joint mobility was methodically avoided during the initial stage, and this was especially true directly following surgical treatment for a joint. Of course, in the presence of a cast, immobility of the encased joints was enforced. Atrophied muscles were built up sufficiently to protect the joints which they controlled before wide ranges of joint motion and walking were permitted. Multiple strains and sprains occurred and increased joint fluid resulted when mobility of the joint was emphasized prior to restoration of the muscles; a good example of this was seen repeatedly following operation on the knee joint when excessive walking was indulged in before the strength of the quadriceps muscles was restored. Unfortunately, it was a common error to consider such knees in need of more immobilization.

In the instance of elective surgical treatment for the joint, rehabilitation was instituted preoperatively with instructions and demonstra-

tions. The patient was taught to control the specific muscle groups most likely to atrophy postoperatively. It was gratifying to learn that by starting the exercises promptly, it was possible to prevent much of the deterioration of muscles and stiffness of joints formerly regarded as inevitable.

At the outset, the weight of the extremities afforded all of the resistance the muscles could move against, and occasionally it was necessary temporarily to remove the force of gravity; but as more resistance was tolerated, more was added. Bags of weights were employed to advantage, and the weights used were lead balls, scraps of steel, dumbbells and so forth. Bags were made of heavy cloth or leather and had padded straps to place over the top of the foot or to grasp with the hand. At the end of convalescence, surprisingly heavy resistance could be negotiated, e. g., a quadriceps muscle often was able to extend the knee against 50 to 100 pounds (about 23 to 45 Kg.) of resistance. De Lorme¹⁵ employed York bar bells to advantage. Occasionally the injured extremity became stronger than the uninjured, and this was observed to be decidedly advantageous in the case of rupture of the anterior crucial ligament. Weight rope-pulley arrangements were particularly valuable for the upper extremities, but were not always satisfactory for lower extremities.

Mobility Stage: During this intermediate stage the emphasis was on restoring joint mobility, but the "power program" was continued and the growing muscle strength was depended on to increase the range of motion. Passive stretching was virtually abandoned by most Army Air Forces orthopedists. Supervision was necessary that muscle strength and endurance be kept a little ahead of the increasing range of joint motion. Better function was derived from a joint with moderately limited mobility and strong activating muscles than from a fully mobile joint moved by weak muscles.

Many standard gymnastic procedures and types of equipment were used to good advantage, e. g., rowing machines, indian clubs, adjustable steps and high and parallel bars. Occupational therapy also had an important place in the mobility stage.

In such an active program of rehabilitation, it was inevitable that an occasional eager patient would go beyond the amount of exercise indicated and incur a brief period of increased pain in the joint, muscle spasm and decreased motion of the joint. Such reactions occasionally caused alarm, but need not have; after a day or two of rest, the program of exercise generally could be resumed. If after particularly strenuous exercise, no increase in pain or decrease in joint mobility appeared by the following day, it was concluded that the exercise was well tolerated.

15. De Lorme, T. L.: Restoration of Muscle Power by Heavy Resistance Exercises, *J. Bone & Joint Surg.* **27**:645, 1945.

Coordination Stage: In the final stage of orthopedic rehabilitation, the emphasis was on restoring precision of function. Conditioned reflexes were brought back into play, and smooth graceful mobility was sought. Occupational therapy was observed to be of the greatest benefit in improving coordination. Gymnastic equipment was also employed, as were games, calisthenics and ward duties.

Limping and malpostures were carefully observed, to prevent their becoming habits. At the earliest possible moment that a natural gait and posture became possible, the patient was persuaded and prodded into assuming them.

PROGRESS IN ORTHOPEDIC SURGERY FOR 1946

A Review Prepared by an Editorial Board of the American Academy
of Orthopaedic Surgeons

VI. CONDITIONS INVOLVING THE HIP JOINT

Prepared by

JOHN J. FAHEY, M.D., CHICAGO

NIEBAUER and King,²⁷¹ stimulated by the reports of Burns and Watson-Jones, performed arthrodesis of the hip by internal fixation with the Smith-Petersen nail and the additional insertion of a $3\frac{1}{2}$ inch (9 cm.) venable screw from the inner surface of the ileum, in the region of the anterior inferior iliac spine, into the femoral head to increase the rigidity and strength of the fixation. The exposure is similar to that used by Smith-Petersen for hip arthroplasty. The fixation is performed with the hip at a 35 to 50 degree flexion. Impaction insures earlier union. In 15 of 24 cases a painless stable hip was obtained, and in 7 motion and pain were present. There was infection of the wound in 1 instance, and 1 patient died after pulmonary embolism. Three of the failures were due to fractures of the "vitallium" nail, and in another case the nail penetrated the pelvis too deeply and pulled out. Aseptic necrosis of the femoral head was thought to be a contributing factor in the unsuccessful results in 2 cases. Fracture of the nail is less likely to occur if stainless steel nails are used.

Patrick²⁷² performs arthrodesis of the hip for osteoarthritis with the patient under spinal anesthesia, using a Smith-Petersen nail and a fibular graft. Three twist drills of different diameters, $\frac{1}{2}$ inch (1.27 cm.), $\frac{7}{16}$ inch (1.12 cm.) and $\frac{3}{8}$ inch (0.96 cm.), used for making a tunnel for the graft, are needed to correspond to the possible variation in the size of the fibula. They are inserted over a guide pin. The guide should be withdrawn when the nail has been driven in 2 inches (5 cm.). This procedure has been found useful in the treatment of aseptic necrosis of the femoral head following pin fixation.

Freiberg²⁷³ stated the belief that the basic principle of the Brittain ischiofemoral arthrodesis of the hip is sound. He performed the

271. Niebauer, J. J., and King, D.: Arthrodesis of the Hip (for Arthritis) Produced by Internal Fixation, *J. Bone & Joint Surg.* **28**:103-112 (Jan.) 1946.

272. Patrick, J.: Pin and Graft Arthrodesis for Osteo-Arthritis of the Hip, *Lancet* **2**:9-11 (July 6) 1946.

273. Freiberg, J. A.: Experiences with the Brittain Ischiofemoral Arthrodesis, *J. Bone & Joint Surg.* **28**:501-512 (July) 1946.

operation on 7 patients. In 4 of the 6 patients operated on for tuberculosis fusion occurred in seven to nine months; in another it occurred after one year. A full thickness tibial graft from the same leg, including the medial and anterolateral surfaces, was used.

Kleinberg²⁷⁴ discusses the etiology, pathologic changes, symptomology and treatment of incipient slipping of the upper end of the femoral epiphysis. He advocates elimination of the epiphysal plate by drilling in an attempt to secure early fusion of the femoral head and neck. Freedom from weight bearing may be necessary for one to two years, or until the epiphysal plate has disappeared and bone lamellas extend from the neck into the head, denoting good union. The patient is kept recumbent with plaster immobilization for three months postoperatively, after which time the cast is changed and ambulation on crutches, with a single hip spica, is allowed. This is usually worn for three months, when the patient is provided with a brace for the hip.

In a study of 100 cases of slipped capital femoral epiphyses, Finch and Roberts²⁷⁵ found 2 cases that were of the epiphysal coxa valga type, with a well formed acetabulum, which they believe are the first reported in the English literature. The authors were opposed to forcible manipulation in internal rotation, as they thought that degenerative changes resulted in 1 of their cases from this maneuver. [ED. NOTE (J. J. F.).—The authors point out that no lateral roentgenograms were made. This would be important in determining the relationship of the head to the neck.]

Foley²⁷⁶ believes that a slight backward rotation of the femoral head can be accepted in a case of slipped femoral epiphysis, as it will not appreciably affect subsequent function. He advocated the use of the Smith-Petersen nail in the early stages. When the epiphysal displacement has passed beyond the acceptable limit, he suggests subtrochanteric osteotomy, accepting some uncorrected deformity rather than risking aseptic necrosis resulting from osteotomy of the femoral neck. [ED. NOTE (J. J. F.).—In the cases in which preslipping symptoms and sudden displacement have occurred, it is possible to obtain a satisfactory result by gentle manipulation and pin fixation.]

For the preslipping and minimal states of slipped femoral epiphyses, Sullivan²⁷⁷ advocates drilling of the femoral neck across the epiphysal

274. Kleinberg, S.: Incipient Epiphyseolsthesis of the Hip, *Am. J. Surg.* **72**: 190-201 (Aug.) 1946.

275. Finch, A. D., and Roberts, W. M.: Epiphyseal Coxa Valga: Report of Two Cases, *J. Bone & Joint Surg.* **28**:869-872 (Oct.) 1946.

276. Foley, W. B.: Treatment of Slipped Upper Femoral Epiphysis: President's Address, *Proc. Roy. Soc. Med.* **39**:201-212 (Feb.) 1946.

277. Sullivan, R. F.: Slipping Epiphysis of Head of Femur in Growing Children, *Bull. New England M. Center* **8**:78-84 (April) 1946.

cartilage plate and the insertion of match grafts, as described by Howorth. It may be possible to have the patient ambulatory in one month when this type of treatment is instituted, and early union is obtained. His second choice is the insertion of a Smith-Petersen nail, as used by Philip Wilson. Operative procedures devised for advanced cases are given a guarded prognosis. [ED. NOTE (J. J. F.).—The author's second choice of treatment in the preslipping and minimal slipping stages or pin fixation is usually favored.]

Luzuy²⁷⁸ reports satisfactory results in 7 of 14 cases of degenerative arthritis of the hip in which treatment was by obturator pelvic neurectomy. The pain disappeared, walking became easier and mobility was increased, especially in regard to abduction, in the patients who responded favorably to treatment. Tavernier reported satisfactory results in 38 per cent of his cases when the same procedure was used and in 70 per cent when the crural branch was included in the excision. The increased abduction resulting from the neurectomy may be important in influencing the results, as the pressure forces are changed. Patients having pain on the inner aspect of the thigh, adductor contracture and bilateral involvement and patients who are poor risks are especially good candidates for this procedure.

Papin and Lafargue²⁷⁹ expressed the opinion that none of the usual methods of treatment for chronic painful arthritis of the hip is satisfactory. Resection of the obturator nerve, suggested by Camitz twelve years ago, fell into disfavor because of the numerous failures. The authors realized that the hip is also supplied by the sciatic and crural fibers, and in 1943 they suggested total sensory denervation. Nine of 10 patients who underwent resection of the obturator nerve at the first stage and resection of the remaining nerve supply at a second operation are free from pain when resting and walking. Tavernier has had successful results with the same procedure in 90 per cent of 24 patients.

Padovani²⁸⁰ discusses resection of the obturator nerve in the therapy of coxarthria and states that the percentage of cures is not high. It is more suitable for patients with flexion and adduction contractures, in aged persons with minimal deformity and in cases of bilateral disease in which there is good motion. It is often a useful adjunct to other surgical procedures. [ED. NOTE (L. D. B.).—Neurotrophic joints have been reported after this procedure.]

278. Luzuy, M.: Results of Treatment of Fourteen Cases of Coxarthria by Section of Sensory Nerves, *Mém. Acad. de chir.* **71**:221-225 (May-June) 1945.

279. Papin, E., and Lafargue, P.: Total Sensory Denervation of Hip in Chronic Painful Arthritis, *J. de méd. de Bordeaux* **121-122**:330-336 (June) 1945.

280. Padovani, P.: Resection of Obturator Nerve in Therapy of Coxarthria, *Semaine d. hôp., Paris* **22**:139-141 (Jan. 28) 1946.

Diez ²⁸¹ performed radicotomy of the third and fourth lumbar roots for the relief of pain in a case of arthritis deformans of the hip. The patient was free from pain, and the muscular contracture had disappeared, which permitted good motion.

Judovich and Nobel ²⁸² suggest that the pain in osteoarthritis of the hip may be due in some instances to involvement of the periarticular structures, particularly the tendons of the gluteus minimus and medius and the pyriformis muscles. Patients exhibiting tenderness in the area of insertion of these tendons may be relieved by local infiltration of procaine hydrochloride.

O'Brien, Shy and Bubliss ²⁸³ report on 103 consecutive cases of trochanteric fractures of the femur in which treatment was by internal fixation. In their early cases, in which they used local anesthesia, there was a mortality of 43.4 per cent. The use of a combination of pentothal sodium and nitrous oxide reduced the mortality to 8.8 per cent. The authors used a Kirschner wire as a guide and inserted the nail under roentgenographic control. The Neufeld nail plate was used in 90 cases, the Moore plate in 8 and the Smith-Petersen nail with the Thornton attachment in 5. They prefer the Neufeld nail because it follows the guide pin more accurately and has less tendency to pull out. One nail broke after three months when the patient walked and another in one year when the patient fell. Medial protrusion of the plate into the hip occurred in 10 of the earlier cases. If the end of the plate is $\frac{1}{2}$ inch (1.27 cm.) from the articular surface, this complication will be reduced. There was a mortality of 21.4 per cent, as compared to a 39.2 per cent mortality, reported by Leydig and Brookes, for 302 trochanteric fractures treated conservatively at the St. Louis City Hospital and reported several years previously. The results were excellent in 40 per cent of the cases, good in 22 per cent and fair in 16 per cent; in 22 per cent the patients were unable or unwilling to bear any weight, and the results were classified as poor.

Speed ²⁸⁴ stresses Pauwel's principle of measuring the degree of the obliquity of the fracture plane in relation to the horizontal plane in the determination of the method of treatment and the prognosis in fractures of the femoral neck. A truly impacted or abduction fracture in which the angle is 30 degrees or less between the horizontal line

281. Diez, J.: Treatment of Pain in Arthritis Deformans of Hip by Means of Posterior Radicotomy of Third and Fourth Lumbar Nerves: Case, *Bol. y trab., Acad. argent. de cir.* **29**:841-842 (Sept. 5) 1945.

282. Judovich, B., and Nobel, G.: Relief of Pain in Osteoarthritis of the Hip Joint, *Am. J. Surg.* **72**:72-73 (July) 1946.

283. O'Brien, R. M.; Shy, J. C., and Bubliss, N. J.: Internal Fixation of Trochanteric Fractures of the Femur, *J. Bone & Joint Surg.* **28**:791-797 (Oct.) 1946.

284. Speed, K.: Subtrochanteric Osteotomy for Ununited Fracture of the Neck of the Femur, *Ann. Surg.* **124**:576-585 (Sept.) 1946.

and the fracture line offers a good prognosis. If the head is necrotic, one of the reconstruction operations is indicated. For a living head, osteotomy and plaster immobilization offers encouraging results. One fatality occurred from pulmonary embolism among 10 patients varying in age from 62 to 78 years when this procedure was used. The remaining 9 patients have slight shortening, and some can walk without a cane.

Hall and Berg²⁸⁵ report on 14 patients, ranging in age from 59 years to 86 years, with nonunion of the femoral neck; some had aseptic necrosis of the femoral head and were subjected to a McMurray osteotomy and plaster immobilization. All were considered unsuitable for more serious surgical procedures, such as fusion or reconstruction. All had limited hip motion, especially with respect to internal rotation. Stability was uniformly satisfactory, with most of the Trendelenburg signs eliminated. Hip flexion to 90 degrees was obtained, and pain was minimal. No walking splints or other aid, except elevation of the shoe, is necessary.

Henderson and Henderson²⁸⁶ discuss bone grafts for ununited fractures of the femoral neck and describe in detail the technic used in articular osteosynthesis and in the extra-articular method. The bone graft was used in the treatment of ununited fracture of the femoral neck in 90 cases between the years 1913 to 1945. This represents only about 1 in 10 patients admitted to the hospital for nonunion. In the past twenty-five years the percentage of cases in which union was obtained has been satisfactory, and the functional results in those cases have been gratifying. In the past ten years extra-articular operation in which a fibular bone graft has been employed has been adopted in the majority of cases. Among 24 cases of extra-articular osteosynthesis, excellent results were obtained in 12, good results in 4 and fair results in 1. There is little shock, and the procedure can be employed for older patients. A sufficient portion of the neck and a viable head must be available.

Inclan²⁸⁷ believes that poor reduction, improper fixation, circulatory disturbances and infection are responsible for the late complications of fractures of the femoral neck. He advocated internal fixation with a bone graft in all cases of subcapital fracture and for early circulatory

285. Hall, C. L., and Berg, C.: Osteotomy for the Treatment of Ununited Fracture of the Femoral Neck, *J. Internat. Coll. Surgeons* 9:20-35 (Jan.-Feb.) 1946.

286. Henderson, M. S., and Henderson, E. D.: Bone Grafts for Ununited Fracture of the Neck of the Femur: A Report of Ninety Cases, *J. Internat. Coll. Surgeons* 9:26-34 (Jan.-Feb.) 1946.

287. Inclan, A.: Late Complications in Fractures of the Neck of the Femur, Treated by Nailing, Bone Grafting, or Both, *J. Internat. Coll. Surgeons* 9:36-50 (Jan.-Feb.) 1946.

changes in the neck and head. Of 47 patients with fracture of the femoral neck treated only by nailing with the Smith-Petersen nail and followed for more than a year, 3 have had nonunion and 3 have had late complications, giving an incidence of poor results in 19.1 per cent. Among 21 patients treated with the use of a bone graft and a Smith-Petersen nail, complications developed in only 9.5 per cent of those followed for one year.

[ED. NOTE (J. J. F.).—It would be necessary to have a longer follow-up study in order to determine the merit of the method advocated.]

Venable and Stuck²⁸⁸ have developed an operation consisting of a muscle flap transplant to the femoral head and neck to relieve symptoms of "aseptic necrosis" and painful osteoarthritis. Only 1 of the 27 patients who underwent the operation failed to obtain striking relief from pain. A flap from the medial half of the vastus lateralis is dissected free and transplanted into a slot cut in the neck of the femur, extending from the base of the head to the trochanter. [ED. NOTE (J. J. F.).—It would be interesting to see if just cutting the slot in the bone would give the same result.]

Crile²⁸⁹ describes 3 cases of so-called hernias of the adductor muscles of the thigh. In 2 of these cases the operation had been performed previously after diagnosis of hernia, and it had failed in both. One of the patients was reoperated on and the protruding muscle excised. In the third case no previous operation had been performed and the pathologic process was clearly demonstrated. This condition has been found to be the result of ruptured adductor muscles, usually caused by a heavy blow or a sudden strain. When the ends of the muscles retract, the upper end retains its innervation, continues to function and contracts itself into a thick mass on the upper inner aspect of the thigh. The mass disappears when the muscle is relaxed and reappears when it is contracted. Hernias, however, occur at a point where the cutaneous nerves penetrate a congenital defect in the fascia. They may be multiple, and a history of trauma is usually not obtained. The author feels that correction of the deformity cannot be accomplished by repair of a supposed defect in the fascia. In early cases, repair of the muscles may give a satisfactory result. Conservative treatment and reassurance are recommended. If the presence of the mass is objectionable from a cosmetic standpoint, it can be excised, but not with complete assurance that the symptoms will be relieved.

288. Venable, C. S., and Stuck, W. G.: Muscle Flap Transplant for Relief of Painful Monarticular Arthritis of Hip, *Ann. Surg.* **123**:641-655 (April) 1946.

289. Crile, G., Jr.: Traumatic Rupture of Adductor Muscles of the Thigh, *U. S. Nav. M. Bull.* **46**:719-723 (May) 1946.

Hucherson and Denman²⁹⁰ discuss iliopectineal bursitis and report 2 cases. The psoas tendon passes over a thin portion of the capsule between the upper ends of the iliofemoral and pubocapsular ligaments, with a small subpsoas bursa averaging 5 by 7 cm. in length and 2 to 4 cm. in width intervening. This bursa is practically always present, and it has been found to communicate with the joint cavity in approximately 15 per cent of the cases. Early symptoms are pain, change in gait, flexion of the hip and knee, adduction and external rotation of the hip and protection against hyperextension. Fulness or swelling in the groin is a late finding. Pain is elicited by hyperextending, abducting or internally rotating the thigh. There is tenderness to pressure over an area about 2 cm. in diameter just below Poupert's ligament and lateral to the femoral artery. Hypertrophic changes in the hip are a predisposing factor to iliopectineal bursitis. The condition must be differentiated from cold abscess, perinephritic abscess pointing in the groin, femoral and inguinal hernia, varicosity of the saphenous vein, hydrocele of the cord and lymphadenopathy. Rest, heat and a hip spica with a window over the femoral triangle for the application of heat will shorten the period of recovery.

Ghormley and Flashman²⁹¹ discuss arthrokata-dysis, better known as Otto pelvis, or intrapelvic protrusion of the acetabulum, and report 1 case. The patient was a 12 year old girl whose symptoms began three years previously. She walked with crutches, and there was practically no motion of her hips. She had an unusual amount of intrapelvic protrusion. She was treated by various methods, i. e., straight and lateral traction, a padded turnbuckle splint between the thighs with the ankles drawn together and long leg casts with a bar joining the ankles and a turnbuckle between the thighs. The final treatment consisted of the insertion of Kirschner wires through the upper end of the femurs and the application of a double spica cast to the hips, with an apparatus incorporated to permit lateral traction on the wires. When she was dismissed one year after admission to the hospital she was on crutches, but there was active flexion of 15 degrees in the left hip and of 30 degrees of the right, and there had been a gain in the intrapelvic diameter.

Longhi²⁹² discusses the anatomic pathogenesis and the clinical and roentgenographic features of ischiopubic osteochondritis. He describes two types, one with changes in enchondral ossification due to growth

290. Hucherson, D. C., and Denman, F. R.: Non-Infectious Iliopectineal Bursitis, *Am. J. Surg.* **72**:576-579 (Oct.) 1946.

291. Ghormley, R. K., and Flashman, F. L.: Arthrokata-dysis: Report of Case, *Proc. Staff Meet., Mayo Clin.* **21**:108-112 (March 6) 1946.

292. Longhi, L.: Ischium-Ischiopubic Osteochondritis, *Arch. di ortop.* **57**: 119-145 (March) 1942.

disturbances and the other with changes in enchondral ossification due to local infection.

Françon²⁹³ reviews the clinical features of an entity called the Debray-Milkman or the looser syndrome. The diagnosis is confirmed by roentgenologic study, which shows multiple symmetric pseudofractures. The condition leads to invalidism, progressive emaciation and cachexia. He states that a response may be expected in about two months after treatment with intravenous injections of 10 cc. of 10 per cent calcium gluconate and the administration of vitamin D.

Buchanan²⁹⁴ found ankylosis bilaterally in a white cadaver; the patient was mentally defective and was 38 years of age at the time of death. He had been a bed patient for the last seven years of his life. There were extra-articular arches of bone located anterior to the joints, and on one side the bony arch extended from the region of the anterior inferior iliac spine to the anterior surface of the femur. Microscopic section showed the ankylosing factor to be true bone. The tendons of the iliopsoas and pectineus muscles were not involved. The iliofemoral ligaments could not be demonstrated, and it is probable that the ossification occurred in these ligaments. [ED. NOTE (J. J. F.).—Roentgenograms of the hips appear to show ossification in the region of the iliopsoas muscles rather than in the iliofemoral ligament.]

Elizalde²⁹⁵ reports 2 cases of obstetric dislocation of the hip associated with fracture of the femur. The condition was caused by forcible maneuvers during breech deliveries. The clinical picture is characterized by apparent disproportion in length of the infant's limbs after a difficult labor, and there is intense pain on motion of the injured limb. A swelling of the inguinal region of the thigh and the gluteal region occurs a few days later, with a brownish induration and a slight elevation of the cutaneous temperature, and the limb is held in slight flexion and external rotation. The treatment consists of reduction by the Lorenz procedure as used for congenital dislocation of the hip. The hip is immobilized in a position of 135 degrees of flexion, 40 degrees of abduction and slight rotation. The results in both cases were good.

293. Françon, F.: False Coxarthrosis Due to Looser Syndrome (Formerly Maurice Debray-Milkman Syndrome), *Rev. du rhum.* **12**:181-183 (Aug.) 1945.

294. Buchanan, A. R.: Bilateral Extra-Articular Ankylosis of the Hip Joint, *J. Bone & Joint Surg.* **28**:31-384 (April) 1946.

295. Elizalde, E. A.: Obstetrical Dislocation of the Hip Associated with Fracture of the Femur, *J. Bone & Joint Surg.* **28**:838-841 (Oct.) 1946.

VII. CONDITIONS INVOLVING THE SHOULDER, NECK AND JAW

Prepared by

DAVID BOSWORTH, M.D., NEW YORK

Lesions of the Scalp.—Kelly²⁹⁶ records 2 cases in which total avulsion of the scalp was treated by replacement, with successful results. He states that the requisite points for the accomplishment of this end are to keep the avulsed skin cool and moist and to prepare the replaced skin by meticulous removal of the subcutaneous tissues and fat with a razor or a sharp scalpel. It is felt that the use of cool isotonic sodium chloride solution over the entire exposed area as well as over the avulsed scalp increases the survival time of the living tissues. He further presents cases of avulsion of skin elsewhere, as from the index finger, the lower half of the patella and the second finger. The results were successful in all cases when the avulsed skin was denuded in the described manner before replacement. The literature concerning avulsions of the scalp (scalping) is completely reviewed by the author, and he suggests that the reported poor results are attributable to improper preparation of the avulsed tissue before its resuture in place.

[ED. NOTE.—The method described is a far cry from the previously employed technic of drilling the external cortex of the skull with multiple holes in persons who had been scalped by Indians. The literature on this method is most interesting; though healing was delayed over a long period for epithelization of the area from the sides, many excellent results accrued. The question arises as to whether multiple drilling and replacement of the denuded integument, actually representing a full thickness skin graft, would not be a safer procedure than replacement of such material on an intact external table of the skull.]

Facial Maxillary Injuries and Reconstruction.—The possibility of a demonstration of a temporomandibular hydrarthrosis preoperatively is presented by Bachman and Bershon.²⁹⁷ They report a case and mention one other similar incident recorded in the literature.

296. Kelly, M. W.: Avulsion Injuries Including Two Cases of Avulsion of Scalp, *Am. J. Surg.* **72**:103-109 (July) 1946.

297. Bachman, A. L., and Bershon, A. L.: Hydrarthrosis: Roentgenographic Appearance of Temporomandibular Hydrarthrosis, *Radiology* **46**:251-257 (March) 1946.

An analysis of the movements of the jaw, both normal and abnormal, is presented by Burman and Sinberg.²⁹⁸ They report a study based on the clinical examination of the temporomandibular joints of 105 patients, approximately half of whom were normal. The clinical manifestations, complaints and roentgenologic signs as compared with those in a large series of normal persons are described. The problem of interposed meniscus is considered under three headings, namely, the untreated joints recovering spontaneously, the untreated joints in which secondary arthritic changes develop and the fixed joints relieved only by surgical intervention. Differentiation is made between the dislocation associated with laceration of the meniscus which is irreducible and dislocation which can be treated with manipulation. The review of pathologic lesions of the temporomandibular joint is extensive. Correlation of all findings with actual pathologic changes is accomplished.

[ED. NOTE.—This paper represents a basic contribution which should be read and studied.]

Blocker and Weiss in two articles take up facial maxillary injuries. The first²⁹⁹ records the increased incidence of this type of injury in World War II. The problems are presented in orderly fashion and point out the fact that patients must be treated with respect to their general condition as well as to the local injury. The uses of various types of graft and their manner of application are illustrated. Procedures illustrated include the use of split grafts, full thickness grafts and grafts of derma and fat and the use of cartilage and bone as well as of delayed pedicle grafts. The second paper³⁰⁰ supplements the first to a considerable degree and more specifically applies to the grafting of bony defects of the jaw. A detailed outline of operative technic and postoperative care is given. Defects from 3 to 12 cm. in length in the lower jaw are reported successfully bridged. The lengthy preparations, with removal of the sequestra and fragments of teeth, and the subsidence of infection are emphasized. The use of cancellous grafts from the ilium is advocated. The application of 43 grafts without mishap is reported. An extensive bibliography accompanies the article. In a third paper³⁰¹ Blocker reviews the data in his previous paper and again presents his method of operative iliac grafting of defects in the

298. Burman, M., and Sinberg, S. E.: Condylar Movement in Study of Internal Derangement of Temporomandibular Joint, *J. Bone & Joint Surg.* **28**:351-373 (April) 1946.

299. Blocker, T. G., Jr., and Weiss, L. R.: Maxillofacial Injuries, *J. Indiana M. A.* **39**:60-63 (Feb.) 1946.

300. Blocker, T. G., Jr., and Weiss, L. R.: Use of Cancellous Bone in Repair of Defects About Jaws, *Ann. Surg.* **123**:622-638 (April) 1946.

301. Blocker, T. G., Jr.: Cancellous Bone Grafts to the Jaw, *Surg., Gynec. & Obst.* **84**:553-561 (April) 1947.

mandible. Once more he emphasizes the necessity of proper preparation of the tissues before operation is attempted to secure osteogenic repair.

[ED. NOTE.—These three papers contain material providing an excellent outline for those interested in the repair of defects in the mandible. The difficulties encountered are emphasized by the authors' specific warning as to the preparation of the bone graft site and the insistence that this must be satisfactory before the grafts are attempted. Their stand on the use of cancellous bone for graft material seems excellent.]

Leach and others³⁰² report data from 1,148 cases of facial maxillary injury in an evacuation hospital where the incidence of such injuries was 7.1 per cent. Since they are rather specific in their article as to the best manner of treatment, including immediate care and other subsequent measures in the preparation for definitive surgical procedures at a later date, this work represents an outline of the care of such injuries whether they be in persons of military or civilian status. They include interesting tables on causative wounding agents, the type of wound and the number of associated injuries of the face seen. Definite recommendations for specific treatment of wounds of the various parts, such as the eyes, eyelids, external ear, lip, tongue, mouth and floor of the mouth, are included. Methods of treatment of the various bony structures, such as the mandible, zygomatic arch and mastoid process, are concisely stated. Problems arising out of laceration of the external carotid artery, the lingual artery, the internal jugular vein and the common carotid artery are reviewed. The comparative efficiency of anesthetic methods used and the indications for each are included. Types of tracheotomies and indications for them are discussed. The authors conclude that primary closure of the neck for facial injuries is the treatment of choice.

[ED. NOTE.—This paper represents a rather full discussion of the subject and includes much statistical data.]

Articles on ankylosis of the jaw and on procedures to relieve it include two by Eggers. In his first article³⁰³ in 1941 he recommended the use of fascia lata interposed between resected bony surfaces. In his later article³⁰⁴ in 1946 he advised the implantation of double thickness

302. Leech, C. H.; Drum, B. C., and Osterhagen, H. F.: Management of Plastic Maxillofacial Wounds in Evacuation Hospital, *Surg., Gynec. & Obst.* **83**: 462-473 (Oct.) 1946.

303. Eggers, G. W. N.: Ankylosis of Mandible, *South. Surgeon* **10**:1-7 (Jan.) 1941.

304. Eggers, G. W. N.: Arthroplasty of Temporomandibular Joint in Children with Interposition of Tantalum Foil: Preliminary Report, *J. Bone & Joint Surg.* **28**:603-606 (July) 1946.

tantalum foil on either side of the resected previously ankylosed area. This article is essentially a report on a 4 year old child on whom arthroplasty of the temporomandibular joint was carried out by the latter method. He includes a follow-up report on 3 previous cases, the longest period of follow-up being two years and ten months. Results are reported as satisfactory in all cases.

Dingman³⁰⁵ presents a valuable article in which the pathologic process in ankylosis of the temporomandibular joint is concisely stated. Operative procedure for treatment of the ankylosis is given in detail. He emphasizes the importance of not inserting any material into the operative defect. Wide excision of the condylar region of the mandible under local anesthesia is stated as preferable, and he feels that it is unwise to perform this bilaterally at a single sitting.

Brown and Peterson³⁰⁶ present a paper describing a similar technic without the interposition of tissue after removal of the ankylosis.

[ED. NOTE.—It has been my experience that satisfactory results are secured by wide resection of bone to remove the ankylosis in the temporomandibular articulation. There appears to be no advantage in the introduction of extraneous substance, particularly since most authors agree that débridement of the wound should be done if such material exists at the time the ankylosis is removed.]

Lesions Involving the Cervical Region.—Adson, Young and Ghormley³⁰⁷ present a review of the etiologic factors which have been considered in spasmodic torticollis, with a detailed discourse on the type of operation which they now feel is necessary in severe cases in which the condition has not responded to conservative measures. When several muscles on both sides of the neck are affected, a major procedure is recommended by the authors. This consists of bilateral section of the spinal accessory nerve and bilateral rhizotomy of the motor roots of the three upper cervical nerves. In some cases in which this procedure has been employed the spinal accessory nerves have been divided in the cervical region prior to laminectomy and rhizotomy. It is stated that this extensive procedure has given some satisfactory results, although in certain cases subluxation, with anterior curvature of the upper cervical vertebrae, has resulted. In such instances the patient's head falls forward and the mandible is pressed

305. Dingman, R. O.: Ankylosis of Temporomandibular Joint, *Am. J. Orthodontics (Oral Surg.)* **32**:120-125 (Feb.) 1946.

306. Brown, J. B., and Peterson, L. W.: Ankylosis and Trismus Resulting from War Wounds Involving Coronoid Region of Mandible: Three Cases, *J. Oral Surg.* **4**:258-266 (July) 1946.

307. Adson, A. W.; Young, H. H., and Ghormley, R. K.: Spasmodic Torticollis: Severe Organic Type Treated by Combined Operation, Rhizotomy and Fusion, *J. Bone & Joint Surg.* **28**:299-308 (April) 1946.

into the neck in such a manner as to interfere with breathing, swallowing and speaking. This deformity has been partially overcome by the application of a Thomas collar or of some similar support. Because of this complication, the authors have devised an operative procedure in which a bone graft from the ilium is placed from the occiput over the upper cervical region of the spine. The procedure then becomes one of combined nerve division and spinal fusion. It is appreciated by the authors that this is a major operation and is only to be employed when the patient is actually incapacitated as a result of spasmodic torticollis.

A review of the cervical rib syndrome by McGowan³⁰⁸ scans the literature on the mechanism of the symptomatology associated with this condition. In the differentiation from the scalenus-anticus syndrome he includes the conditions of (1) supraspinatus injury, (2) subarachnoid tumor, (3) cervicodorsal sympathalgia, (4) Raynaud's disease, (5) cervical arthritis, (6) brachial plexus neuritis and (7) slipped intervertebral disk. He reviews what he considers to be the mechanics at work when a cervical rib is present along with symptoms. He divides the symptoms resulting from such a condition into neurologic and vascular. The neurologic symptoms include pain of a sharp, lancinating nature located in the scapular region, with radiation down the arm or at times up the side of the neck. Pain is worse at the end of the day, and in women it is aggravated by certain types of work depressing the shoulder. Anesthesia, paresthesia, burning, tingling or numbness may be present. The circulatory symptoms include blanching, tingling or coldness. These occur during the carrying of certain objects or the assumption of certain positions for long intervals such as those assumed while sleeping. When the symptoms described are present, McGowan believes the presence of a cervical rib as demonstrated in the roentgenogram, to be responsible. Surgical procedures for both division of the scalenus anticus muscle and removal of cervical ribs are presented in detail. He warns of the danger of injury to the brachial plexus, subclavian artery, phrenic nerve and cervical pleura as well as to the thoracic duct on the left. He mentions the possibility of an accessory thoracic duct on the right and presents 4 case reports in detail. In these reports he differentiates between the findings in cases of occlusion of the subclavian artery and those in cases of vasospasm of the artery following sympathetic irritation. By keeping these in mind, he states, cases may be divided into those in which relief can be obtained successfully by the performance of a simple myotomy of the scalenus anticus and those in which rongeur-ing away of a portion of the cervical rib is necessary when such a rib causes compression

308. McGowan, J. M.: Cervical Rib: Role of Clavicle in Occlusion of Subclavian Artery, *Ann. Surg.* **124**:71-89 (July) 1946.

of the subclavian artery against the clavicle. A report on 3 of 9 patients subjected to combined scaleniotomy and partial resection of the cervical rib is given. All were followed; the results were excellent, with no deaths or sequelae.

Spurling and Scoville³⁰⁹ thoroughly review the salient features of diagnosis of ruptured cervical intervertebral disk. They make a plea that pain in the arm and shoulder be considered as possible basic symptoms for the diagnosis of this condition. It is suggested that neuritis in the presence of the scalenus anticus syndrome is too often thought of as the cause of symptomatology when in fact a ruptured fifth or sixth cervical disk may be present. It is felt that accurate localization of the lesion on clinical findings alone is usually possible. This they believe can be accurately verified by pantopaque myelography. They state that although conservative treatment may relieve symptoms, operative removal of the lesion is justified when conservative measures fail on the basis that it is a simple, safe procedure and the results are excellent. Statistical data on 12 patients are presented.

[ED. NOTE.—This article should be read by those interested in operating for cervical disks. While removal of most cervical disks is not too intricate a procedure and the results are excellent in the hands of those thoroughly conversant with surgery of the cervical spine, the procedure may prove difficult, and disasters when they occur are of considerable magnitude.]

Whiteleather, Semmes and Murphey³¹⁰ present a brief résumé of the clinical findings when typical herniation of a cervical intervertebral disk occurs. Abnormalities which may be present in roentgenograms of the cervical region of the spine are shown. It is stated that a loss or a reversal of normal cervical lordosis, either complete or partial, with narrowing of the intervertebral space, calcified particles of disks and osteophytes or proliferative spurs projecting into the foramen and from the anterior margins of the body, along with alterations in the size and shape of the foramens, increased mobility of the vertebral body and defects in the pantopaque myelogram may not be pathognomonic but are highly suggestive of injury to the disk. They suggest that when correlated with the history, symptomatology and neurologic findings, they are strongly confirmatory. The fact is stressed that when there is recent or acute protrusion no roentgenologic abnormalities

309. Spurling, R. G., and Scoville, W. B.: Lateral Rupture of Cervical Intervertebral Discs: Common Cause of Shoulder and Arm Pain, *Surg., Gynec. & Obst.* **78**:350-358 (April) 1944.

310. Whiteleather, J. E.; Semmes, R. E., and Murphey, F.: Roentgenographic Signs of Herniation of Cervical Intervertebral Disk, *Radiology* **46**:213-219 (March) 1946.

need be present. They commend the routine use of oblique roentgenograms of the cervical region of the spine. As can be seen, their paper deals with the various abnormalities which the roentgenologist feels may be helpful in making a diagnosis of herniation of the intervertebral disk.

[ED. NOTE.—It would seem that a clearer picture of the herniated cervical disk causing pressure on the nerve roots was provided by the pattern of the complaints and the clinical picture than by the roentgenologic findings. This paper's importance lies in the insistence on a satisfactory roentgenologic examination of the cervical region of the spine and on enumeration of changes to be found therein. Such changes have been found to be confusing and not to correlate too well with the location of the herniated disk as found at operation.]

Lesions of the Shoulder.—A comparative anatomic study of the dissected brachial plexus, pectoral muscles, coracoid area and structures in the upper extremity of the gorilla as contrasted with those in man is reported by Kaplan.³¹¹ He brings out the variations in anastomosis of the median and ulnar nerves in the forearm of man, with a clarification of obscure points in the interpretation of the unexplained absence of paralysis of the intrinsic muscles of the hand in cases of injury high in the ulnar nerve. He emphasizes the possible change in position of the posterior interosseous nerve in the upper part of the forearm. In another article³¹² he describes the occasional presence of Langer's muscle of the axilla, first noted in 1846 and described under the name of "*Aschselbogen*." It is a flat muscle originating from the tendon of insertion of the latissimus dorsi and inserted into the reflected portion of the tendon of the pectoralis major near the bicipital groove.

Soule³¹³ reports on 18 patients with dislocation of the acromioclavicular articulation, in 14 of whom there subsequently developed osseous deposits in the region of the coracoclavicular ligament. Anatomic consideration of ligamentous structures about the acromioclavicular articulation are briefly considered. The cases are presented in some detail as to the mode of injury, method of treatment and eventual roentgen findings. The author concludes that post-traumatic ossification of the area of the coracoclavicular ligament is a common sequela of dislocation of this joint and more commonly seen when such dislocations are complete. Calcifications are reported to appear in from

311. Kaplan, E. B.: Notes on Upper Extremity of Gorilla: Clinical Application, *Bull. Hosp. Joint Dis.* 7:129-136 (Oct.) 1946.

312. Kaplan, E. B.: Surgical Anatomy: Langer's Muscle of Axilla, *Bull. Hosp. Joint Dis.* 6:78-79 (Oct.) 1945.

313. Soule, A. B., Jr.: Ossification of Coracoclavicular Ligament Following Dislocation of Acromioclavicular Articulation, *Am. J. Roentgenol.* 56:607-615 (Nov.) 1946.

three to six weeks after injury and to become complete in about eight to ten weeks. It is stated that if ossification is not obtained within six weeks of injury it will probably not appear at a later date. The author speculates that ossification of the area of the coracoclavicular ligament may be of some aid in restoring stability to the damaged region.

A review of the differential diagnosis in cases of painful lesions of the shoulder is made by McBride.³¹⁴ The classification includes (1) lesions in which pain is referred to the cervical region, (2) rheumatic disorders, (3) injuries to the capsule and the tendon and (4) injuries to bones and joints. An extensive subclassification is given. There is a discussion of the differential diagnosis of these conditions. A short discussion of various modes of treatment is included. The paper emphasizes the fact that a thorough knowledge of all conditions leading to pain in the shoulder and disability is imperative if responsibility for treatment is to be undertaken.

Thirty-one cases in which operative correction was done for recurrent dislocation of the shoulder are discussed by Myers.³¹⁵ He emphasizes the importance of the pathologic changes which occur in the capsule, the joint cavity and the posterolateral section of the head of the humerus. A detailed method of capsulorrhaphy is presented. Results are evaluated and reviewed in terms of the type of dislocation, the total treatment given and the pathologic changes present. All patients were reported to present a detachment of the capsule from the rim at the site of the defect. Seventy-three per cent were found to have a fracture of the glenoidal labrum. Half of the patients had osteochondritic or degenerative changes in the humeral head. It is stated that intra-articular damage is not caused by the capsulorrhaphy done. The longest period of follow-up was eighteen months.

A series of fourteen operations performed on 13 patients for repair of recurrent dislocations of the shoulder by a new technic is given, by Crosby.³¹⁶ The procedure consists essentially of anchoring of the tendon of the long head of the biceps in the bicipital groove. Recurrence was recorded in 4 cases. A second operation, consisting of fascia lata reefing, was performed in these cases. Thereafter a third operative procedure was used in 32 cases consisting of transplantation of the long head of the biceps from its supraglenoid tubercle origin to the

314. McBride, E. D.: Injuries to Shoulder, *New Orleans M. & S. J.* **98**:533-541 (June) 1946.

315. Myers, O. R.: Experience with Capsulorrhaphy for Recurrent Dislocation, *J. Bone & Joint Surg.* **28**:253-261 (April) 1946.

316. Crosby, E. H.: Surgical Procedure for Repair of Recurrent Dislocation of Shoulder Joint: Preliminary Report, *J. Bone & Joint Surg.* **28**:809-812 (Oct.) 1946.

acromion process. Only 8 cases have been followed for more than one year. One recurrence of dislocation took place.

[ED. NOTE.—In both of the series mentioned a longer postoperative period of follow-up would seem indicated. Discussion of this matter should not be closed without mention of the efficacy of procedures which employ transplantation of the scapularis tendon.]

McLaughlin deals with the musculotendinous cuff of the shoulder in three papers. In his first paper³¹⁷ he speaks of the exposure and treatment of tears with retraction. He reemphasizes the necessity for care in the performance of deltoid dissection to avoid damage to axillary nerve branches infiltrating the muscle. Osteotomy of the acromion process is advocated, and he reports that the outer fragment is discarded and the remaining stump beveled and reshaped without ill effect. He reports that good bony union has occurred in all cases, whether fixation was used or not, when the fragment has not been discharged. He discusses the treatment of incomplete and complete ruptures of the tendinous cuffs. Under the heading of complete rupture he classifies transverse rupture, longitudinal splits, tears with retraction and massive avulsion of the cuff. The operative procedure of choice is discussed at considerable length. In his opinion, the transacromial approach is useful for surgical procedures involving the cuff, capsule, humeral head, long biceps tendon and intra-articular cavity of the shoulder. He believes benefit is gained by excising and discarding the outer fragment of the divided acromion. He states that retracted tears of the musculotendinous cuff can be repaired according to this method. It is stated that massive avulsion of the cuff per se does not warrant fusion of the shoulder. A report of 32 cases is summarized in tabular form, including cases of uncomplicated tears of the musculotendinous cuff. A report of 8 cases of what was stated as massive avulsion of the cuff is given. McLaughlin agrees with Codman that the formation of a typical crescentic or triangular hiatus type of defect eventually occurs if repair is not done. In his second paper³¹⁸ he treats of the differential diagnosis of lesions of the musculotendinous cuff. Requirements for such diagnosis include a detailed history, compatible subjective symptoms, the presence of functional derangement of a typical nature and local signs of damage together with elimination of any other condition. He describes the anatomy of the tendinous cuff and the action of its component parts. Dislocations of the shoulder, with fractures of the greater tuberosity,

317. McLaughlin, H. L.: Lesions of Musculotendinous Cuff of Shoulder: Exposure and Treatment of Tears with Retraction, *J. Bone & Joint Surg.* **26**: 31-51 (Jan.) 1944.

318. McLaughlin, H. L.: Lesions of Musculotendinous Cuff of Shoulder: Differential Diagnosis of Rupture, *J. A. M. A.* **128**:563-568 (June 23) 1945.

are reviewed and divided into three types. In his third paper³¹⁹ he records the pathologic process, the course and the treatment of calcific deposits about the shoulder. He believes the origin of such deposits to be the end result of a degenerative change following trauma or overuse of the arm. Secondary rupture of degenerative fibers may occur. The mechanism of the production of pain consists in inflammation centered in the vascular peritendinous tissues and fairly well restricted to them. These include the short rotator tendons of the shoulder and the synovial floor of the subdeltoid bursa. Therefore inflammation resulting from irritation by calcific deposits may produce the clinical syndrome of tenosynovitis and subdeltoid bursitis of the shoulder. The variation of the symptomatology produced by lesions appearing identical in roentgenograms is recounted. As regards therapy, it is stated that chronic lesions may warrant operative removal of the deposits as the only certain and speedy method of obtaining permanent relief. For acute conditions, the treatment of choice is stated to consist of puncture of the tense deposits and aspiration of their contents by needle under local anesthesia.

[ED. NOTE.—The first two of these papers are recommended in their entirety. While I would not agree that transection or removal of a portion of the acromion process should be done, they are stimulating to one interested in lesions of the shoulder cuff.]

319. McLaughlin, H. L.: Lesions of Musculotendinous Cuff of Shoulder: Observations on Pathology, Course and Treatment of Calcific Deposits, *Ann. Surg.* **124**:354-362 (Aug.) 1946.

VIII. CONGENITAL DEFORMITIES

Prepared by

J. H. KITE, M.D., ATLANTA, GA.

SINCE 1941 I have begun the section on congenital deformities with an article by Josef Warkany. I will follow the now established custom and do the same this year.

He says ³²⁰ that congenital defects are deviations from the normal which are present at birth. Such defects may be morphologic or functional and may be hereditary or acquired, but they are always determined before birth. The fact that mammalian congenital defects arise in the maternal uterus, seemingly uninfluenced by visible environmental factors, has kept their origin obscure and their prevention beyond human influence. Superstition and confusion have been and still are prevalent in the speculations on the origin of congenital defects, more so than in any other field of human pathology.

We must look to embryologic morphology and embryologic chemistry for an understanding of prenatal development. A continuous chain of physicochemical reactions regulates the development of the unborn child from the first cell, the zygote, to the complex multicellular organism of the newborn. Any interruption of these reactions results in damage to the embryo or fetus. The time of the injury is of great importance, since the defects are determined to a certain extent by the developmental state of the affected organism. In general the damage is more serious the earlier the embryo is injured. Within the first ten weeks of gestation the unicellular ovum develops into an embryo which has the principal features of a human being. All the organs and organ systems are essentially determined and recognizable in the third month. In this first period of organogenesis, the embryo is extremely vulnerable and injuries result in severe malformations. The second period of gestation, which lasts from the third month to birth, is essentially devoted to growth. Adverse factors acting in this period may cause disease or retarded development.

320. Warkany, J.: Some Factors in the Etiology of Congenital Malformations, *Am. J. Ment. Deficiency* 50:231-241 (Oct.) 1945.

There can be no doubt that many congenital malformations are genetically determined. By this statement it is meant that a defective gene or an unfavorable combination of genes present in the zygote determines a developmental disturbance which results in congenital malformations.

Environmental interference with prenatal development may also lead to congenital malformations. Infectious, actinic, toxic and nutritional factors can interfere with normal embryonic development and result in congenital defects.

Among the infectious agents leading to congenital malformations, the virus of rubella should be mentioned first. Prenatal infection with the protozoan toxoplasma results in a congenital syndrome of internal hydrocephalus or microcephalus, chorioretinitis and calcifications of the brain. The effects of prenatal syphilis are well known.

Exposure of the embryo to large doses of roentgen rays may result in congenital malformations. A number of cases are on record which show that inadvertent irradiation of the uterus of a pregnant woman may lead to microcephaly, mental deficiency and malformations of the eye and the extremities in the child. The roentgen ray doses employed as well as the developmental stage of the embryo determine the type of malformation.

It is possible and even probable that toxic factors can induce congenital malformations. It has been asserted that alcohol, lead, various contraceptives, parental tuberculosis and syphilis may adversely influence prenatal development and result in congenital malformations.

[ED. NOTE (J. H. KITE).—See the “Progress in Orthopedic Surgery” for the four previous years for reports by Warkany and his co-workers. They have shown that many skeletal abnormalities have followed the feeding of female rats a diet deficient in riboflavin. The newborn rats have shown a shortening of the lower jaw, shortening or absence of the tibia, fibula, radius and ulna, fusion of ribs and syndactylism of various degrees. When riboflavin, or liver which is a good source of riboflavin, is added to the deficient diet, only normal young are born.]

Syndactylism resulting from genetic factors has occurred in mice. Syndactylism also occurs in the young of mothers fed a diet deficient in riboflavin and in the young of mothers exposed to roentgen rays during pregnancy. The first type of syndactylism is hereditary, the latter types are not.

An abnormal character may be due to an abnormal gene. But the same abnormal character may appear in the presence of a normal gene if the chain of developmental processes is interrupted by injurious environmental factors.

Eugenic measures must take into account not only genetic factors but also the environmental conditions which can influence the development of the unborn child.

The question has been raised whether environmental factors operating for the first time after the fertilization of the ovum can cause congenital abnormalities.

Conte, McCammon and Christie³²¹ say that many theories have been suggested to explain the causation of congenital malformations. A number of observations have been made to support the contention that the environment of the ovum after fertilization can be influenced sufficiently to modify its growth and development. It is, nevertheless, generally accepted that most congenital malformations are due to intrinsic or inherited factors. The evidence that defective germ plasm prior to fertilization of the ovum is responsible for congenital malformations was reviewed by Murphy. He could find no evidence to suggest that malformations result from environmental factors which operate for the first time after fertilization has taken place.

Recently, however, it has been suggested that there is a relationship between certain acute infectious diseases suffered by the mother early in her pregnancy and the development of anomalies in the offspring. Gregg, in 1941, was the first to suggest this in his report of 78 cases of congenital anomalies in children whose mothers suffered from a virus infection early in their pregnancies. Swan reported 43 similar cases.^{321a}

One hundred and thirty-four cases have been reported in the literature in which maternal rubella in pregnancy was followed by congenital abnormalities. In all but 3 of these cases the rubella occurred in the first trimester of pregnancy. Congenital cataracts, congenital heart disease and definite mental retardation of the child usually resulted.

It is difficult to evaluate the significance of these reported cases because it is not known how often virus infections occur without congenital malformations or how often malformations occur without virus infections. In other words, there are no controls for the reported cases.

Five additional cases of maternal rubella and congenital abnormalities of the offspring were reported from Vanderbilt University School of Medicine. In 4 of these the maternal rubella occurred in the first trimester of pregnancy. The 4 infants had congenital malformations of the heart and mental deficiency, and 3 had congenital cataracts. In

321. Conte, W. R.; McCammon, C. S., and Christie, A.: Congenital Defects Following Maternal Rubella, *Am. J. Dis. Child.* **70**:301-306 (Nov.-Dec.) 1945.

321a. Swan, C.; Tostevin, A. L.; Mayo, H., and Black, G. H. B.: Further Observations on Congenital Defects in Infants Following Infectious Diseases During Pregnancy, with Special Reference to Rubella, *M. J. Australia* **1**:409 (May 6) 1944.

the fifth case the mother had rubella at seven months of gestation. Congenital cataracts and cerebral aplasia were noted in the infant.

Maternal rubella was noted in 4.2 per cent of the cases of congenital abnormalities surveyed. This exceeds by at least ten times the actual case rate of maternal rubella for the child-bearing age group in the population at large.

They conclude that these associations furnish additional evidence that environmental factors operating for the first time after fertilization of an ovum can cause congenital abnormalities.

Prendergast³²² made a review of the reported cases of congenital defects in children born of mothers who had rubella during the first three months of pregnancy. This was a California survey.

Gregg expressed the opinion that the majority of cases of rubella concerned in his study occurred during a so-called epidemic in 1940 which affected rather widespread areas in Australia. The attacks of rubella were rather severe in most cases. In California the rubella occurred in a mild, almost subclinical form. If the virus in the cases occurring in this country is similar to the virus in cases in Australia, it would seem that it must be of an attenuated nature.

In the fall of 1944 a survey was made among some of the ophthalmologists, pediatricians and obstetricians in California to obtain an idea of the incidence of congenital anomalies among children whose mothers had had rubella during the first three months of pregnancy.

A total of 80 cases of congenital cataract and 10 cases of other ocular defects, 32 cases of cardiac defects and 10 cases of other congenital anomalies were reported.

Because the greater number of cases to date has been reported from the western part of the United States, one wonders whether such congenital defects are more prevalent in this part of the country or whether, like the epidemic of shipyard conjunctivitis of several years ago which started in Hawaii and spread to the Pacific coast and thence to the rest of the United States, this condition has spread to the Pacific coast from Australia, where it was first reported, and is now making its way across the country. Further surveys will be of interest from this point of view.

Fox and Bortin³²³ approached the problem of malformations following rubella in early months of pregnancy by studying the patients who had it. They say that the investigators had failed to cite the total number of women who had rubella during pregnancy and gave birth to children with no congenital defects. The entire subject must be

322. Prendergast, J. J.: Congenital Cataract and Other Anomalies Following Rubella in Mother During Pregnancy, *Arch. Ophth.* **35**:39-41 (Jan.) 1946.

323. Fox, M. J., and Bortin, M. M.: Rubella in Pregnancy Causing Malformations in Newborn, *J. A. M. A.* **130**:568-569 (March 2) 1946.

interpreted from the public health point of view. They gave the following as their conclusions:

1. Rubella has occurred in the city of Milwaukee in epidemic proportions approximately every ten years.

2. In a survey of the period 1942, 1943 and 1944, 22,226 cases of rubella were reported, of which 152 involving married women were investigated. Eleven of the women were pregnant at the time they had rubella.

3. Of the 11 pregnant women who had rubella, 5 had the disease during the first two months, 4 during the second to the fourth month, 1 in the seventh month and 1 in the ninth month.

4. One stillbirth occurred among the 11 cases; 1 woman had twins, both normal, and 1 woman gave birth to a child with congenital cataracts at the end of a normal pregnancy and delivered a normal child at the end of a pregnancy during which she had rubella in the second month.

5. The records do not justify consideration of termination of pregnancy because of rubella.

6. The occurrence of congenital malformations in virus disease in pregnant women is a subject deserving of further careful investigation.

Parsons,³²⁴ from Birmingham, England, reviews the literature and concludes that instances of rubella should be reported in England and Wales, especially when it occurs in married women.

In June 1946 he gave the Fifth Blackader Lecture before the Canadian Medical Association on "The Effect of Ante-Natal conditions on the New-born Child."³²⁵ He stresses the need for more study of "ante-natal paediatrics." Most of this lecture is of pediatric interest. He discusses the effect of maternal diet, the nutritional state of the mother and the health of the mother as it affects the newborn child. The effects of rubella are again reviewed. Two paragraphs of this lecture are quoted:

One of the earliest enquiries about the effect of ante-natal conditions on the new-born with which I am familiar was the question put to our Lord by his disciples; "Master who did sin, this man or his parents that he was born blind?" You remember the reply, "Neither hath this man sinned nor his parents, but that the works of God might be made manifest in him." Is it fanciful to think that therein lies an explanation of the existence of disease and that the research worker is a fellow worker with God?

It is interesting to note that Shakespeare (*A Midsummer Night's Dream*, Act. V, Sec. 2) refers to some of the deformities now associated with German

324. Parsons, L. G.: Maternal Rubella as a Cause of Congenital Defects, *Brit. M. Bull.* 4:193-196, 1946.

325. Parsons, L. G.: The Effect of Ante-Natal Conditions on the New-Born Child, *Canad. M. A. J.* 55:327-336 (Oct.) 1946.

measles but attributed them to "the foul fiend Flibbertigibbet," "who gives the web and pin, squints the eye and makes the hare lip." "Web and pin," according to Goldbloom, our authority on Shakespearean paediatrics, probably refers to cataract or a corneal scar. A cynic (Vertue) has said recently that "science has done nothing about Flibbertigibbet unless you count the suggestion that one of his other names is German measles."

Davis, a senior at the Medical College of the State of South Carolina, was awarded a prize for a paper on "Congenital Malformations following Rubella in the Mother." This is a good review of the literature, with a summary of the conclusions of the various authors.

Wilson and Brown³²⁶ report on 2 patients with fracture of the atlas and with congenital anomalies who were admitted to the hospital within ten days. Clinically, these anomalies are discovered only rarely and are seldom a cause of confusion in the diagnosis of fracture. They mention the work of Jefferson, who did much to dispel the belief that fractures of the atlas carry a high mortality rate and that they are extremely rare. He also pointed out that they usually result from force exerted on the top of the head with the spinal column fixed in the neutral position, causing a bursting fracture of the atlas ring. This is commonly of the posterior arch through the groove for the vertebral artery.

Ivie³²⁷ reports a white soldier who injured his neck while wrestling. He suffered immediate weakness of the extremities but no loss of sensation. After lying quietly for half an hour, he gradually regained strength in the extremities but noticed a tingling sensation in the fingers and toes, more severe on the left side. Roentgen examination of the cervical region of the spine showed a partial dislocation of the atlas on the axis, anteriorly and laterally. The odontoid process of the second cervical vertebra was absent. The dislocation was reduced by traction of the head by means of Crutchfield tongs applied to the skull. The patient was comfortable in traction, and symptoms of tingling of the fingers and toes and weakness of the extremities disappeared. If fusion of the cervical region of the spine is not done, the patient should be carefully informed of the potential danger of his condition. There is always the possibility of a recurrence and perhaps of serious damage to the cord.

Gilmore and others³²⁸ report 2 cases of spinal anomaly which could not be demonstrated by the conventional methods but which could be

326. Wilson, J. W., and Brown, N. M.: Congenital Anomaly and Fracture of the Atlas: Two Cases, *Canad. M. A. J.* **55**:52-53 (July) 1946.

327. Ivie, J. M.: Congenital Absence of the Odontoid Process, *Radiology* **46**: 268-269 (March) 1946.

328. Gilmore, J. H.; Stauffer, R. C., and Jacobs, L. G.: Two Cases of Spinal Anomaly, Best Demonstrated by Laminagraphy, *Radiology* **46**:515-517 (May) 1946.

outlined clearly by laminagraphic studies. They found a hemivertebra in 0.5 per cent of examinations of the cervical regions of the spine, 0.2 per cent of examinations of the thoracic region and 0.05 per cent of examinations of the lumbar region. One case involved a soldier who was struck on the back of his neck while boxing. He experienced immediate pain and gradual increasing tenderness of the cervical muscles, especially on the left, with some limitation of motion. The head and neck were held rigid as a protective mechanism. There was no radiating pain. Laminagraphic study showed an assimilation of the atlas in the occiput, with a supernumerary hemiatlas on the left. Bed rest and leather traction for fourteen days led to relief of symptoms.

Schachter³²⁹ gives a description of two cases of hypertelorism (Greig). The first concerns a child of 5 and represents the pure type. The second involves a girl of 13 who had in addition a one-sided harelip. Both patients were mentally deficient and had relaxed joints. He gives a discussion of symptomatology and diagnosis.

The annual review of the Klippel-Feil syndrome was made this year by Erskine, of England.³³⁰ He reviews the literature from the time the first case was reported by Klippel and Feil in 1912 to the present time and reports 1 case.

The three characteristic clinical features of the syndrome are shortness of the neck, limitation of movement of the head and lowering of the hair line.

Postmortem studies in cases of the Klippel-Feil syndrome are rare. The descriptions are usually limited to the osseous deformity. The essential features of the cervical deformity are synostosis of two or more cervical vertebrae and flattening and widening of the vertebral bodies.

Other abnormalities occur, some of which depend on the primary cervical lesion, such as torticollis, facial asymmetry, lowered nipple line, kyphosis and thoracic scoliosis, the last occasionally due to a hemivertebra.

The consensus regarding the cause of the Klippel-Feil syndrome is that it is a disorder of segmentation. It has been stated that the Klippel-Feil syndrome is not hereditary or familial; yet there are a number of cases reported in which it occurred in parents and children. The incidence is equal in males and females.

The most constant features are synostosis, flattening of the vertebrae, narrowing or obliteration of the intervertebral disks, shortening of the cervical region of the spine and spina bifida. In at least some cases it

329. Schachter, M.: Deux observations d'hypertélorisme de Greig, *Ann. pædiat.* **167**:199-206, 1946.

330. Erskine, C. A.: An Analysis of the Klippel-Feil Syndrome, *Arch. Path.* **41**:269-281 (March) 1946.

appears that the characteristically lowered hair line is due to the same type of hirsutism as that found in other regions in spina bifida occulta. It is doubtful if reduction in the number of vertebrae is an essential part of the disorder.

There is evidence that the anomaly has a genetic basis.

Soule³³¹ made a survey of all case reports and articles on mutational or cleidocranial dysostosis published from January 1929 through March 1944. He reported 6 additional cases. Mutational dysostosis is a condition, frequently transmitted by parents to offspring, which is characterized by multiple, variable developmental skeletal anomalies. The more prominent and frequent of these anomalies are aplasia of the clavicles, delay in closure of fontanelles and cranial sutures, brachycephalia, prognathism, irregularities in dentition and structural abnormalities in the skull bones, vertebrae, sacrum, pelvis, femurs, scapulas, metacarpals, metatarsals and phalanges.

The cardinal features of the syndrome are: (1) a varying degree of aplasia of the clavicles; (2) overdevelopment of the transverse diameter of the cranium coincident with delay in ossification of the fontanelles, and (3) hereditary transmission.

The term "cleidocranial dysostosis" was applied to this condition by all writers until 1936, when Rhinehart called attention to its mutational character and to the variety and inconstancy of findings and proposed the name "mutational dysostosis" as more rational and descriptive.

In cases in which there has been a hereditary background, transmission has been by both male and female members of the family to a nearly equal degree. In many instances the disease has appeared in two successive generations and has been lost in the following generation. In eight families the disease appeared in three successive generations, in four families it appeared in four successive generations and in one family it appeared in five successive generations. No authentic instance could be found in which the disease appeared in one generation, skipped one or more generations and then appeared in a subsequent generation.

The etiology of the disease is unknown, but it is unquestionably associated with a defect in the parental germ plasm. There is a faulty anlage in the system of membranous bones, the skull bones and clavicles, which is also present occasionally in the bones of chondral origin.

Defects in the clavicles are among the commonest lesions found in mutational dysostosis and may vary from a small defect in one clavicle to complete absence of both bones. Usually small, bony stumps are present

331. Soule, A. B., Jr.: Mutational Dysostosis (Cleidocranial Dysostosis), *J. Bone & Joint Surg.* 28:81-102 (Jan.) 1946.

mesially, which articulate with the sternum and to which the sternomastoid and pectoralis major muscles are attached. In about 10 per cent of all reported cases the clavicles are entirely absent.

The appearance of most of the patients is strikingly similar; in spite of racial differences, there is almost a family resemblance. The most troublesome defects are the dental abnormalities, with their attendant complications. If the arches of the feet are poorly developed or if there are such changes as genu valgum, coxa vara or coxa valga, difficulties in gait and posture may be experienced. If the pelvis is contracted, normal labor may be impossible. If spinal anomalies are present, symptoms referable to these abnormalities may appear. Treatment is aimed toward alleviation of symptoms produced by the defects.

The inheritance of cleidocranial dysostosis has been carefully reviewed by Lasker.³³² Cleidocranial dysostosis is a rare developmental disease. The number of cases now known, 505 plus 30 doubtful cases, makes it advisable to reassess the dominant mendelian inheritance.

It primarily affects those bones which ossify from membrane, but all parts of the skeleton are sometimes involved. The head is typically large, low and brachycephalic, with persistence of the fontanelles and the metopic and other sutures. The most prominent clinical sign is the lack or the defect of the clavicles and the unusual motility of the shoulder girdle. Little if any disability is ordinarily apparent in affected persons. They usually live out a normal life span.

That cleidocranial dysostosis is a hereditary disease is strongly indicated by the frequency of the multiple familial occurrences and the distribution of cases. Seventy-three families have been reported in which the disease occurred in more than one person. In the seventy-three families, 369 persons are reported affected or probably affected.

Lasker concludes: "We may say with some assurance that the majority of cases of cleidocranial dysostosis are inherited as a Mendelian dominant with high penetrance. It is quite possible that all cases may be explained in this way if the responsible gene recurs frequently as a mutant."

Maddox³³³ reports another case of cleidocranial dysostosis in a 21 year old man who had been in the British Navy two years. He says: "This dystrophy, no longer considered invariably as hereditary, is still sufficiently uncommon (it is doubtful whether 100 cases have yet been described) to warrant a record of fresh case reports."

[ED. NOTE (L.D. B.).—See preceding report for number of cases.]

332. Lasker, G. W.: The Inheritance of Cleidocranial Dysostosis, *Human Biol.* **18**:103-126 (May) 1946.

333. Maddox, J. K.: Cleido-Cranial Dysostosis, *J. Roy. Nav. M. Serv.* **32**: 201-209 (July) 1946.

Its chief interest lies in its symptomless nature and in the adaptation to hard physical work exhibited by nearly all those affected. It is apparent that the clavicle, which appears as a strong link in the shoulder girdle of higher mammals who are intended to climb for their food, can be virtually dispensed with by civilized man. Its four components are aplasia of clavicles, exaggerated transverse diameter of cranium, delay of ossification of fontanelles and hereditary transmission. "A better tetralogy would be dysplasia of clavicles, delay in closure of skull sutures, defective development of the base of the skull and multiple vertebral anomalies."

Association with other congenital defects, including syringomyelia, places the deformity chronologically at an early fetal phase. The clavicle is the first bone in the skeleton to ossify (sixth week). In the argument on the significance of the remnants from the viewpoint of comparative anatomy, it is interesting to note that a consistent accompaniment is incomplete development of the pelvis and ischium, which correspond in the lower extremity of man to the coracoid and precoracoid of the upper extremity of lower animals.

It is important to reassure the affected person that, far from being physically inferior to his fellows, he possesses a unique faculty for escape from a strait jacket, through a ship's scuttle or down a drainpipe.

An unusual developmental abnormality of the arms is reported by the Shahs.³³⁴ They report a case accidentally observed in the dispensary at Ahmedabad. A man of 20 had a bilateral deformity of the arms. The humerus had fused with the radius or the ulna, and there was a suppression of some of the carpal bones and of many of the metacarpals and phalanges, which gave him lobster claw hands.

From Oslo Støren³³⁵ describes bilateral congenital ankylosis of the elbow in two sisters who were brought to him for examination. One of them was 1½ years and the other 6 months old. They were otherwise free from deformities, as were also their parents, whose only children they were. The mother's great-grandfather had three brothers who presented the same anomaly. In Norway there have now been described altogether 7 cases, including these 2. All the patients are from Sunmøre County, and they bear a remarkable resemblance to each other, but no relationship between the families can be found to exist.

The author operated on both elbows of the older child, on one of them when she was 1½ years old and on the other when she was 3.

334. Shah, K. A., and Shah, S. B.: An Unusual Developmental Abnormality of the Arms, *Indian M. Gaz.* **81**:10-11 (Jan.) 1946.

335. Støren, H.: Two Operated Cases of Ankylosis Cubiti Congenita, *Acta chir. Scandinav.* **94**:65-74, 1946.

The operation on the other child was performed when she was at the age of 6 months. The joint first treated showed good results for two and a half years, but the mobility has since decreased. The two joints last operated on have by degrees become stiff.

The author refers to Frostad's account of the development of the joint and of the manner in which this anomaly may be supposed to arise, and he regards it as probable that the muscular rudiments are to be found in the embryonic stage of life and that the muscles are still present at birth but comparatively soon become atrophied.

The operations also showed that the musculature of the elbows was present, although there was considerable atrophy (or absence of development?) both of the muscle and of the triceps tendon. It is worthy of note that the musculature was best developed in the arm earliest operated on. The operation must therefore be performed at the earliest possible age if a good result is to be expected. The author believes that the operation ought to be attempted, as improved technic and more careful after-treatment would probably yield better results than those reported.

The growth cannot be impaired by the operation, as epiphysial lines are not present. If stiffening of the joint should again take place, then care must be taken to secure the most convenient position possible. In most cases the power of rotation is probably preserved.

Patella cubiti, a rare anomaly in the elbow, has been described by Kjelland,³³⁶ of Bergen, Norway. He reviews the literature and adds 2 cases of patella cubiti (os epiphyseos olecrani). The roentgenograms show a small bone embedded in the triceps ligament, with a probable cartilage-covered anterior surface and in form similar to the patella genus. Arthrography in 1 case revealed a recessus-superior-like extension of the joint cavity. An embryonic abnormality is assumed to be the cause.

Curr³³⁷ reports two examples of fusion of the lunate and the triquetrum from the Royal Infirmary of Edinburgh. In both cases roentgenologic examination showed, on one side only, a complete fusion of the lunate and triquetrum, which was obviously a congenital abnormality and was not due to any acquired factor. At no time had there been any reason to suspect that the wrists were anything but normal, and the discovery of the abnormality was purely accidental.

Even though this condition is rare, it is of little importance since it does not interfere with appearance or function.

336. Kjelland, P. M.: A Rare Anomaly in the Elbow—Patella Cubiti, *Acta radiol.* 26:491-496, 1945.

337. Curr, J. F.: Congenital Fusion of Lunate and Triquetrum, *Brit. J. Surg* 34:99-100 (July) 1946.

Alexander and Stevenson³³⁸ present the findings at necropsy in a case of spina bifida, with meningocele.

In the literature, the term "anterior sacral meningocele" has been used to describe a meningocele found in the pelvis in front of the sacrum. In cases in which an adequate examination was possible, a bony defect in the body of the sacrum was usually found. Thus, in these cases there was an anterior sacral spina bifida with an associated meningocele. The case described appears to require a separate classification since the skeletal anomaly was a posterior spina bifida.

It is suggested by the authors that the term "anterior sacral meningocele" be reserved for cases in which the spina bifida is in the anterior portion or the body of the sacrum. "Intrapelvic meningocele" may be used to describe a meningocele lying within the pelvis, it being borne in mind that the meningocele may emerge from the sacral spinal canal either through an anterior sacral hiatus or through a posterior defect in the sacral laminae.

They reported a case of posterior sacral spina bifida associated with a meningocele that protruded into the pelvis through the left greater sciatic foramen and with a teratoma of the sacral region.

Treatment for congenital constriction bands of the extremities has been described by the late H. Eckstein, of Tel-Aviv, and P. M. F. Eckstein.³³⁹ They describe what they think is a new operation for the "amniotic constrictions," or the annular scar-like depression of the skin. After excising the scar, they mobilize the proximal fat to fill in the defect:

After excision of all fibrous scar tissue a tongue of fat was fashioned, superficially by undercutting the proximal skin edge and deeply by dissecting along the muscle plane for a corresponding distance. The resulting pad of fat was then drawn across the skin gap and beneath the distal skin edge, which had also been undercut for its reception. It was finally secured in its new site with a stitch passed through it and the overlying skin, where the thread was tied over a wad of gauze. Lastly, the original incision was sutured more proximally.

A case of hemihypertrophy is described by Rugel³⁴⁰ which exhibited all the typical features of this condition, i. e., vascular cutaneous lesions, unilateral sweating, instability of temperature control, change in the hair and skin, cerebral abnormalities and the obvious inequality of the two sides. Postmortem study disclosed deviation from the accepted

338. Alexander, C. M., and Stevenson, L. D.: Sacral Spinal Bifida, Intrapelvic Meningocele and Sacrococcygeal Teratoma, *Am. J. Clin. Path.* **16**:466-471 (July) 1946.

339. Eckstein, H., and Eckstein, F. M. P.: Foetal Dysplasia of Leg, *Lancet* **1**:52-53 (Jan. 12) 1946.

340. Rugel, S. J.: Congenital Hemihypertrophy, *Am. J. Dis. Child.* **71**:530-536 (May) 1946.

picture of purely unilateral asymmetry. The brain showed tremendous hypertrophy and significant histologic changes.

As to etiology, they say that Gesell's twinning theory of "a union into one organism of two different halves" would fit their patient. They believe that hemihypertrophy is in some way tied up with an embryonic defect of the vegetative nervous system. This affects the trophic function of that system, and the result is a bizarre picture of hemihypertrophy.

Gram³⁴¹ describes 5 cases of hemihypertrophy. In 1 of the cases the malformation was combined with "av nevus flammeus" affecting the other half of the body with the exception of the head. As the vasal disturbance annoyed the patient, it was treated with Bucky rays, with good effect.

In the 4 other cases of pure hemihypertrophy the condition did not cause any harm. The defect is of general pathologic interest and should be known, as it gives rise to misinterpretations.

Scherb³⁴² discusses the causes of congenital deformities and gives the following summary:

The work of W. Brandt on the larvae of amphibians in the caudal budding stage and the conclusions drawn by him as to the genesis of malformations of the limbs are discussed as well as his theories on induction and determination.

The hypotheses of various authors as to the origin of congenital clubfoot are mentioned. In previous communications, the author attributed this deformation to the persistence of a phylogenic residue originating in the foetal shaping of the extensor brevis digitorum, interposed between the peroneus brevis and the tuberosity of the 5th metatarsal bone and which normally disappears during the third month of embryonic life. The origin of congenital clubfoot could then be rendered possible by the action of a gene inhabiting the general development and shaping of the entire foot and preventing the phenomena of induction from eliminating the phylogenic residue mentioned above before the critical or irreversible phase of determination. This residue thus persists and develops with the foot which, during the third month of embryonic life, is deformed and becomes a congenital clubfoot. The existence of a specific isolated clubfoot gene is therefore not likely.

Magnusson³⁴³ reports another method of doing an osteotomy to correct inward torsion in cases of congenital clubfoot. He makes a transverse cut in the lower third of the tibia and an oblique cut in the upper third of the fibula. He says this operative procedure affords the following advantages:

341. Gram, L.: Hemihypertrophy, *Nord. med.* **30**:1061-1063 (May 10) 1946

342. Scherb, R.: Zur Frage der Entstehungsursache angeborener Gliedmassenmissbildungen mit besonderer Berücksichtigung des angeborenen Klumpfusses, *Helvet. pædiat. acta* **1**:99-109 (Nov.) 1945.

343. Magnusson, R.: Rotation Osteotomy, *J. Bone & Joint Surg.* **28**:262-264 (April) 1946.

1. The risk of faulty position in the tibial osteotomy is practically eliminated, as the fibula, untouched in its lower part, serves as a stabilizer.

2. A real derotation of the foot can be performed, with maintained congruence between the joint surfaces of the malleoli and the sides of the astragalus.

3. It is easier for the surgeon to control the derotation by this method than by other methods.

He reports seventeen operations on 13 patients.

[ED. NOTE (J. H. K.).—Various methods of doing an osteotomy for the correction of inward torsion in cases of congenital clubfeet have been devised. Years ago I did a number of osteotomies for this purpose, but I have found little need for the operation during the last ten years. When the deformity of the foot has been well corrected, the osteotomy is seldom needed. When a clubfoot deformity recurs and the child toes in, the first impulse is to rotate the foot outward on the tibia. When the foot is examined more carefully, it is found in most cases that the adduction of the forefoot and the inversion of the foot have not been well corrected. I think the better procedure is to correct the deformities in the foot, and then it is found that the osteotomy is not necessary. Even if there still remains some inward torsion when the knee and foot are compared, the child with a well corrected clubfoot can still walk with the foot straight and can take care of considerable inward torsion without the need of an operation.]

Walter Mercer,³⁴⁴ of Edinburgh, has reviewed most of the congenital deformities of the foot and mentioned the usual treatment. For clubfeet he recommends manipulation and the use of the Denis Browne splint for many months. In regard to arthrogryposis multiplex congenita, he says it is well to recognize this type of congenital clubfoot, since no treatment is likely to have any effect on the condition. The introductory paragraph is of interest:

In a study of congenital disorders of the human foot it is natural to consider man's evolutionary history, since there is little doubt that ever since he evolved into that stage which made him *pithecanthropus erectus* he has been having trouble with his feet. Our ancestor of some twenty million years ago was a small tree-dwelling monkey which even then, by suspending himself by his arms, was being initiated into the vertical posture, although at that time taking no weight upon his feet. The foot was still prehensile and the innermost toe opposed the four outer to produce a grasp, and was therefore not unlike the average pronograde monkey of today. Because of an abundance of food the body increased greatly in bulk, so that the habit of progressing by his hands became a physical impossibility and he was forced to use his feet to help in the carriage of a proportion of

344. Mercer, W.: Congenital Abnormalities of the Foot, *Practitioner* **156**: 88-95 (Feb.) 1946.

his body weight. The continuing disproportion between body weight and strength of hand forced on him a permanent descent to the ground. For some time the early shuffling gait of pre-man was assisted by the hands, but as movements became more perfect the hand was liberated and the feet then bore the whole weight of the body.

[ED. NOTE (J. H. K.).—Arthrogryposis, while difficult to treat, can be corrected by a long series of casts and wedgings. A method which will correct this deformity is also good for the average congenital clubfoot.]

Gunn³⁴⁵ reports 8 cases of clubfeet treated by the use of a rubber band held to the skin by adhesive plaster cuffs. He says that this treatment "results in no atrophy, no shortening, allows perfect form and perfect function and also that "all patients on whom the treatment was begun in the first week were cured with the exception of one infant whose mother failed to cooperate."

[ED. NOTE (J. H. K.).—There are many statements in the article which indicate an unfamiliarity with clubfeet. All extremities which are congenitally deformed show some atrophy and shortening, no matter how early the correction is obtained. The word "perfect" when applied to the form and function of a clubfoot after a short course of treatment sounds a little too good.]

Pierre Marique³⁴⁶ has made a study of congenital clubfeet by the use of lateral bimalleolar roentgenograms, and he thinks that the anterior subluxation of a clubfoot on the leg is the crucial lesion. He expresses the opinion that it is this subluxation which makes it impossible to correct the equinus deformity, because the astragalus is blocked by the marginal border of the tibia.

He says that the treatment of choice for extremely young children consists in reductory manipulations. Since nothing is as frail as the ankle of a newborn infant, any manipulations must be avoided in the first days. The dogma of emergency, widespread by Sayre and by Bade, whose treatment must begin at birth, has led to too many accidents and must be rejected once and for all. One may wait until the end of the first month of life. Any brutality must be repudiated.

He makes the point that before the equinus deformity can be corrected the astragalus must be present exactly in front of the mortice; therefore, the posterior foot adduction has to be corrected. This is obtained much better by the grasp on the heel than by the medium of the forefoot. The reduction is gradually obtained. During the intervals

345. Gunn, R. E.: Foot Deformities Corrected by Rubber Band Traction, J. Iowa M. Soc. **36**:48-50 (Feb.) 1946.

346. Marique, P.: La subluxation du pied bot, Presse méd. **54**:411 (June 22) 1946.

of ten to fifteen days between the sittings, a plaster cast is applied to the foot in the position obtained with effort.

He recommends the use of an anesthetic because the child's movements of defense block the manipulations. Section of the achilles tendon is unnecessary. The flexion of the knee relaxes it enough. When the foot has taken up its normal place under the tibial arch and the osseous contact does not play a part any more, the dorsiflexion becomes possible and the triceps lets itself be stretched.

[ED. NOTE (J. H. K.).—The astragalus is a little farther forward in relation to the tibia in a clubfoot than in a normal foot, but the posterior end of the astragalus is always under the tibia. From a study of roentgenograms, I do not see how there could be any bony block which would keep the astragalus from being pushed back under the tibia into the mortice between the malleoli. Some have thought that the head of the astragalus was larger than normal and that this prevented it from being pushed back under the tibia. Malformations in the ankle joint may play a part in resisting correction, but in the cases in which I have operated there has always been a much enlarged achilles tendon, and I feel that this has more to do with blocking dorsiflexion than any disturbance of the alinement of the astragalus. All the ligaments about the posterior foot and the tibia offer resistance to correction. When a series of lateral roentgenograms are studied from the beginning of treatment until the foot has been well corrected, it is found that the os calcis has drawn forward under the astragalus. Before treatment, the head of the astragalus overlaps the anterior end of the os calcis, but by the time the foot comes well up in dorsiflexion the anterior ends of the two bones are on the same level. It is also noticed that the astragalus has been pushed back under the tibia about the normal amount when the ankle comes up in full dorsiflexion.]

Blumenfeld, Kaplan and Hicks³⁴⁷ have given a fair appraisal of the treatment of congenital clubfeet, with a review of the literature, and have reported the results obtained by three methods from the State University of Iowa. After a careful analysis of their cases, they give the following conclusions:

Treatment of clubfoot should be instituted as early as possible. The Denis Browne splint, alone or complemented in some cases by another form of conservative therapy, gives the best results, especially in patients under one year of age. In cases in which the Denis Browne splint failed to obtain complete correction, or in those patients who are between one and four years of age at the beginning of treatment, wedged casts should be used. In some cases of metatarsus varus, correction can be accomplished with wedged casts. Under certain conditions in private practice, manipulative methods may not be the method of

347. Blumenfeld, I.; Kaplan, N., and Hicks, E. O.: *Talipes Equinovarus*, *J. Bone & Joint Surg.* **28**:765-777 (Oct.) 1946.

choice, but rather of necessity. In expert hands, good results can be obtained by the manipulative method. The manipulative method can be used in patients in the older age groups. Metatarsus varus can either be completely corrected or markedly improved by manipulative methods. Correction must be maintained for a considerable period of time, preferably as described.

This article describes a special cassette holder fashioned out of wood which is used to help in holding the child's feet still and in correct position when roentgenograms are made. This should be useful in getting a true anterior-posterior view.

They mentioned another finding which is interesting: "Most of the well corrected congenital clubfeet treated by wrenchings are pliable. Incompletely corrected feet are usually rigid."

[ED. NOTE (J. H. K.).—They explained that the word "wrenching" is used to denote forceful manipulation under anesthesia, without the use of the Thomas wrench and the wedged bar. It has been my opinion that the rigid feet resulted from the use of too much force. I am sure that if only a little more force is used than could be used with the patient awake, more improvement can be obtained. It is the "gentle manipulation" which is permissible and needed in treatment of the older and more resistant feet. At the close of their article the authors make a significant statement, i. e., "The personal equation of the doctor treating the patient is of the utmost concern, because of the necessity for meticulous care in the taking of the wedges and the application of casts."]

Dr. Stuart A. Thomson,³⁴⁸ of Toronto, who introduced the Denis Browne splint into this country, has designed a spring splint to be used for the older and more difficult clubfeet. "The design of the splint is simply a lateral single bar below the knee brace, with a stop joint. It is fitted on our standard club-foot boot, which is a good boot with a low heel and a thick sole and an outside wedge of three sixteenths of an inch on heel and sole. The two segments of the splint are then united by an adjustable hinge-like apparatus with an intervening spring." He says that with "the advent of the spring splint, the results in recurrent club-foot have improved tremendously."

[ED. NOTE (J. H. K.).—It may be that I have been neglecting the after-care of clubfeet. I never have the children wear a special shoe, or a lift under the lateral border or a night splint. I do have some recurrences, but I think of these as being due to inadequate correction. I believe that if the foot is well corrected the child can wear a normal shoe and lead a normal life, without the parents doing more than stretching the foot in dorsiflexion for a while after the casts are removed.]

348. Thomson, S. A.: A Splint for Treatment of Recurrent Clubfoot, *J. Bone & Joint Surg.* 28:778-779 (Oct.) 1946.

A method for treating an uncorrected clubfoot in childhood has been described by Batchelor.³⁴⁹ The procedure is for a child between 5 and 10 who has an imperfectly corrected foot. "Manipulative trauma tends to produce a vicious circle of false corrections, increasing fibrosis and stiffness, followed by inevitable relapse of deformity, and yet more manipulations and wrenchings." He says that the deformity occurs essentially at the astragalocalcaneoscaphoid joint. The os calcis moves with the forefoot, and if the deformity at the astragaloscaphoid joint can be corrected by drawing the scaphoid around the head of the astragalus, the inversion of the heel will disappear. He states that the astragalus is too long and that it is impossible to draw the scaphoid around it. He shortens the neck of the astragalus by removing a section approximately one third of an inch wide. This allows the scaphoid to be drawn up and out around the head of the astragalus. The gap in the neck is closed. "Immobilization is maintained for four to five months, and the child is then provided with an outside iron, outside T-strap and quarter-inch outside wedge on the sole of the boot." It is claimed that this treatment gives the patient not a perfect foot but a foot on which he can get about until he is old enough for a formal arthrodesis, if this should be necessary.

The medical profession has been criticized for lack of recognition and adequate correction of many disabilities which showed up in army inductees, says Thomson.³⁵⁰ Among the common disabilities of the foot was symptomatic flatfoot. The pediatrician must look for and recognize physical anomalies and evidences of weakness in the baby's foot and must realize that a child does not necessarily have normal feet because he does not have clubfeet.

Some infants have abnormal mobility of the foot in all directions and a particular fondness for an everted calcaneovalgus position. These babies have the tendency to throw their feet, while kicking, from a varus to an extreme calcaneovalgus position. Usually the dorsum of the foot can be brought manually and without force against the antero-lateral part of the leg. The babies often sleep on their bellies, and in this position they habitually evert their feet. When they learn to sit, they assume a position of abduction, with the knees flexed and the feet everted. The eversion of the feet is exaggerated during crawling. When the infant begins to walk, the legs rotate outward, and pronation and eversion of the feet are thereby exaggerated.

349. Batchelor, J. S.: The Treatment of the Uncorrected Clubfoot in Childhood, *Proc. Roy. Soc. Med.* **39**:713-715 (Sept.) 1946.

350. Thomson, J. E. M.: Treatment of Congenital Flat-Foot, *J. Bone & Joint Surg.* **28**:787-790 (Oct.) 1946.

Thomson treats these feet with a "reverse" Denis Browne splint. The feet are strapped to the splint as in the correction of clubfoot except that the bar is bent toward the crotch. When the feet are large enough for shoes, the shoes are attached to the bar to be worn at night.

Dr. J. Warren White, in the discussion of this paper, agrees that the method is excellent and says that in mild cases he has been sticking together the soles of the infants' hypermobile flaccid feet with a commercial adherent or a compound tincture of benzoin and holding them with a 2 inch (5.08 cm.) elastic bandage.

[ED. NOTE (J. H. K.).—In many of these cases of calcaneovalgus feet the outward rotation of the entire leg seems to be a more serious abnormality than the flatfeet. I am observing many more cases of outward rotation of the legs than formerly. In addition to having the mother hold the legs in an inwardly rotated position and the feet in a position which will restore an arch in them, I have been using the reverse Denis Browne splint, and I find it exceedingly useful. I have the shoes attached to the bar so that the rotation can be adjusted and the amount of inward rotation increased as needed.]

A case of congenital talonavicular synostosis associated with hereditary multiple ankylosing arthropathies in a soldier is described by Weitzner.³⁵¹ This was a case of bilateral deformity, with multiple fusions of bones in hands, wrists and feet. A short embryologic aspect of joint development is outlined.

A calcaneoscaphoid bar is reported in 2 soldiers by Magee and Benson.³⁵² One noticed pain after marching 29 miles. The other had stiffness in the ankle. The diagnosis was made only by roentgenologic study. The condition is a congenital ossification in mesenchyme which would ordinarily form the lateral part of the short plantar ligament. The roentgenogram showed a solid bar of bone uniting the antero-internal angle of the calcaneus with the navicular. Abduction and adduction were limited to about half their normal range, and eversion and inversion were absent, but there was no pain on forced movements.

A case of anomalous skeletal development in the foot is described by Sloane.³⁵³ A reduction in the usual number of bones may be effected by fusion or by imperfect definition of those normally present. The feet described were those of a cadaver. The right foot had only four

351. Weitzner, I.: Congenital Talonavicular Synostosis Associated with Hereditary Multiple Ankylosing Arthropathies, *Am. J. Roentgenol.* **56**:185-188 (Aug.) 1946.

352. Magee, R. K., and Benson, R. A.: Calcaneo-Scaphoid Bar, *Canad. M. A. J.* **55**:287 (Sept.) 1946.

353. Sloane, M. W. M.: A Case of Anomalous Skeletal Development in the Foot, *Anat. Rec.* **96**:23-26 (Sept.) 1946.

toes. The head of the talus was fused with the navicular in each foot, and the calcaneum was fused anteriorly with a small, narrow cuboid. The talus was also fused with the calcaneum below. Other minor variations were noted.

Mooney³⁵⁴ described an 8 year old girl with a fracture of the fibula. There was an absence of the tibia and of some of the bones of the foot. He was able to trace syndactylism, cleft hands and cleft feet and intrauterine amputations back in the family for four generations and had the photographs to prove it.

Claussen³⁵⁵ reports a hereditary syndrome consisting of malformation of the tongue and polydactyly. Two children suffering from polydactyly and malformation of the tongue are reported. The first child had two normal sisters and one normal brother; three brothers had congenital deformities and died during their first year. The second child had one normal brother. Consanguinity existed between the two families, and in the second case consanguinity between the parents was proved. Genealogic investigations showed that the malformations were caused by a recessive gene.

O'Rahilly³⁵⁶ describes the roentgenograms made of a girl's foot when she was 3 and again when she was 7. He says that the fate of a supernumerary phalangeal epiphysis was followed roentgenologically; the foot also showed hypophalangism and then hyperphalangism with subsequent symphalangism. Relevant cases from the literature are cited.

Stiles and Hawkins³⁵⁷ discuss webbed toes under the title of zygodactyly. The term zygodactyly was coined by Weidenreich to designate simple webbing between the toes, in contrast with syndactyly, wherein fusion or abnormality of the bony structure of hands or feet is involved.

The webbing characteristic of zygodactyly usually involves the skin and superficial fusion between the second and third toes. Cases have been reported in which other toes have been affected, and Whitney even states that complete webbing of all toes has been reported. The extent of the webbing varies considerably; in some feet it extends to the first joint and in still others to the tip of the toes. Schurmeier, in a study

354. Mooney, V.: Orthopaedic Interest in a Fracture, *Pennsylvania M. J.* **49**:736-738 (April) 1946.

355. Claussen, O.: Hereditary Syndrome Comprising Malformation of Tongue and Polydactylia, *Nord. med.* **30**:1147-1151 (May 24) 1946.

356. O'Rahilly, R.: Radiological Investigation of a Case of Pedal Hyperphalangism and Supernumerary Phalangeal Epiphysis, *Brit. J. Radiol.* **19**:432-434 (Oct.) 1946.

357. Stiles, K. A., and Hawkins, D. A.: The Inheritance of Zygodactyly, *J. Hered.* **37**:16-18 (Jan.) 1946.

of 20,000 drafted men, found only 8 who possessed this trait, the webbing always being between the second and third toes.

It is normal for the toes to be webbed when the fetus is from 5 to 6 weeks old. The web appears to be slightly more extensive between the second and third toes. As the digits develop and elongate, the webbing becomes less noticeable, and the toes by the end of the eighth week become separated, that is, the webbing is reduced to mere remnants at the base of the digits. In the case of zygodactyly, the webbing grows outward with the toes instead of becoming reduced. It can be seen from the embryogeny of webbed toes that zygodactyly appears at birth, but it does not increase as the person grows older.

They publish a pedigree which reveals that 5 persons possess this trait. In every case the webbing extends only to the first joint and in no way impairs the function of the toes. The pedigree reveals that this trait is conditioned by a dominant gene with reduced penetrance. Persons presumably heterozygous for the trait sometimes have normal toes.

Webbing, or zygodactyly, of the second and third toes is not an uncommon human anomaly. Webbing of the third and fourth fingers is rarer, but the occurrence of an interdigital triradius, which marks the site of the webbing, can be present even though the webbing is barely noticeable. In zygodactyly there is no osseous malformation like that found in syndactyly or polydactyly. Penrose³⁵⁸ found that it is more than twice as frequent in males as in females. He has analyzed the material from a number of published pedigrees and has shown that paternal hereditary influence predominates over maternal influence. The phenomenon is interpreted as evidence that the trait is primarily due to incompatibility of the mother to some unknown fetal antigen inherited from the father.

Pipkin and Pipkin³⁵⁹ present a paper to describe polydactyly of the feet only, in which expression both of the abnormality and of its hereditary transmission are highly irregular. They say that in many pedigrees polydactyly is dependent on an irregular dominant gene; that is, the defect is occasionally transmitted by a normal-appearing carrier. In most polydactylous families there is a wide variability in the expression of the abnormal condition. Either or both hands together with either or both feet may be affected. The extra finger or toe may vary from a well formed digit with phalanges and even its own metacarpal or metatarsal bone to a mere fleshy protuberance. Variation in the structure and position of the extra digit often occurs among different affected members of the same pedigree.

358. Penrose, L. S.: Inheritance of Zygodactyly, *J. Hered.* **37**:285-287 (Sept.) 1946.

359. Pipkin, S. B., and Pipkin, A. C.: Variation of Expression of Polydactyly, *J. Hered.* **37**:93-96 (March) 1946.

Spear³⁶⁰ has made a study of flexed fingers in his own family, where the condition has involved 8 persons, including members of both sexes and in five different generations. The terms "camptodactyly" and "minor streblomicrodactyly" may be considered as synonymous. He prefers the term camptodactyly in reference to flexed fingers. Hefner has reported the condition to be a result of a shortening of the tendon of the flexor digitorum sublimis muscle, which controls the movement of the finger. The finger affected is the little finger, though others may occasionally show the defect too. The condition being one of permanent flexion to varying degrees, the person affected cannot straighten the finger, and it remains in a state resembling an inverted V. Camptodactyly seems to be due to a single dominant, with the phenotypic expression influenced by genetic and environmental modifiers. There is evidence that the character is linked with hair color, but the data are not extensive enough to prove the point.

360. Spear, G. S.: The Inheritance of Flexed Fingers, *J. Hered.* **37**:189-192 (June) 1946.

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VOLVULUS OF THE CECUM

With a Review of One Hundred Cases in the Literature and a Report of Six New Cases

J. L. DONHAUSER, M.D.

AND

S. ATWELL, M.D.

ALBANY, N. Y.

VOLVULUS of the cecum is regarded as a rare condition, but in many cases it has masqueraded for years as chronic or recurrent appendicitis before a severe attack revealed the true diagnosis. The number of cases in which the disease goes unmasked is unknown. When one considers the embryology of the intestinal tract and the many anomalies contained therein, it is surprising that volvulus of the cecum and of the terminal portion of the ileum does not occur more commonly. It is probable that many cases have existed, however, without having been reported.

The first description of cecal volvulus was written by Rokitansky in 1841. Since that time only from 300 to 400 cases have been reported. Most of the cases occurred in Central European countries and in Russia, where the incidence of cecal volvulus is greater than in England or in the United States. Jacobsen reported an incidence of acute intestinal obstruction due to cecal volvulus of 11.6 per cent; other European authors reported an incidence of about 5 per cent (Sweet). From 1916 through 1946 the "Quarterly Cumulative Index Medicus" listed sixty-three papers on torsion of the cecum, of which fourteen were published in the United States. In 1905 Corner and Sargent collected 57 cases and added 6 of their own. This report reviews the articles in the American and English literature and adds 6 cases which were observed in the Albany Hospital.

Acute intestinal obstruction occurs in the form of cecal torsion in the United States in about 1 per cent of cases. The following percentage incidence has been reported: at Massachusetts General Hospital, 1.15 per cent (Sweet); at Touro Infirmary, 1.4 per cent (Browne); at Harlem Hospital, 0.67 per cent (Rothman); at New York Hospital, 0.85 per cent (Cornell), and at Albany Hospital, 4.3 per cent.

Torsion or volvulus of the cecum has been defined as a "condition in which there is torsion, limited to the cecum, ascending colon and adjacent portion of the small intestine" (Grace, quoting Gastellier,

From the Department of Surgery, Albany Hospital and Medical College.

Moutier and Procher). The axis of torsion in cecal volvulus may be of three types, according to Weinstein: (1) the cecal bascule, in which the posterior surface of the cecum looks forward and the axis of rotation is transverse, (2) rotation in an oblique axis, in which the cecum may occupy the umbilical or even the left hypochondriac region and (3) rotation of the cecum about its long axis.

The cecum is the proximal portion of the large bowel that lies below the level of the top of the ileocecal valve. It is an asymmetric, thin-walled sac about 6 cm. in length by 7 cm. in width. In adults it usually lies in the right iliac fossa on top of the iliopsoas muscle, to which it is attached in varying degrees by areolar tissue. The ileum joins the cecum on its posteromedial aspect, and about 4 cm. below the appendix arises at the junction of the three tinia.

The cecum and the appendix first appear as an out-pocketing of the midgut about the sixth week of development. As the primitive intestine reenters the peritoneal cavity and starts to rotate around the axis formed by the superior mesenteric artery, the cecum and the appendix move to the left. About the eleventh or twelfth weeks they lie just below the liver to the left of the midline. From there they travel across to reach the right hypochondriac region about the fourth month. Usually during the later months of intrauterine life and the first few months after delivery, the cecum descends into the right iliac fossa. While the descent is taking place, the great omentum grows down over the ascending colon and the cecum. The omentum and the ascending mesocolon then fuse with the primitive posterior parietal peritoneum. Anomalies of the cecum result if any of these processes stop short of completion or are carried too far. The various combinations that may occur are well described by Wolfer, Beaton and Ansen.

Hyperfixation of the hepatic flexure, ascending colon or terminal end of the ileum and hyperdescent of the cecum are contributing factors to torsion of the cecum, but the essential anomaly is hypofixation. Wangenstein has said that "volvulus of the cecum is only possible in the absence of fixation of the cecum or the presence of a mesocecum sufficiently mobile to permit torsion." Weinstein added that there must be a fixed point about which the bowel can rotate. Waugh laid stress on the ascending colon being the only segment of the intestine throughout the alimentary tract that has to support semisolid material against the action of gravity and to drive it vertically uphill. Elsewhere the contents are fluid or the path to be followed by them is oblique, horizontal or downhill. An abnormal mobility of the cecum and the ascending colon is a prerequisite to a volvulus of this portion of the intestinal tract, the degree of mobility depending on the length of the mesentery.

The structure of the cecum tends to aggravate torsion, once it has started. According to Alvarez' gradient theory of intestinal peristalsis,

the gradient of the cecum is low or reversed so that material tends to accumulate there. Cannon, working on the cat, showed that the receptively relaxed cecum and the ascending colon, on receiving the liquid contents of the small intestine, undergo activity in the form of antiperistalsis which retards and churns their contents for a considerable period. This delay favors both fermentation, with formation of gas, and absorption of fluid. In addition, the ileocecal valve is in many persons a competent one way valve so that liquid fecal material may continue to enter the cecum but material from the cecum cannot enter the ileum. Consequently, if there is an obstruction of lumen preventing the cecum from emptying, it distends rapidly, which embarrasses the blood supply and thereby reduces its absorptive power. As the cecum distends, it tends to kink across its long axis because the curve of the iliac fossa and the attachment of the ileum tend to pull it medially. Corner and Sargent emphasized the importance of acquired lateral pouches of the cecum, arising from the distending influence of gas produced by processes of bacterial fermentation in which stasis is present for some time. Flint spoke of the cecum as being a cesspool. According to Homan, there is a functional disturbance in which a "most interesting but little understood factor is the power of rapid gas formation possessed by the intestinal tract." Weinstein theorized that the rapid distention in the involved loop is due to deficient oxygen supply to the twisted loop, which favors the growth of anaerobic bacilli.

Various authors have measured the mobility of the cecum at the time of necropsy. Harvey found unnatural free motion of the cecum and the ascending colon in 13.3 per cent of examinations performed on 105 infants at necropsy; Piersol found it in 14 per cent, Treves in 26 per cent and Smith in 31 per cent. According to Grace, it has been estimated that from 10 to 19 per cent of cadavers "show a degree of mobile cecum sufficient to permit volvulus to develop, there being a congenital lack of adequate fixation of the cecocolon." Chalfant reported that there was excessive mobility of the cecocolon in about 20 per cent of persons of all ages, and Wolfer and others found that in 11.2 per cent the "cecum was sufficiently mobile as to allow the development of a volvulus" (in 125 normal cadavers). Torsion of 180 to 360 degrees is common, but it may occur up to 520 to 720 degrees. Tightness of the twist rather than the number of turns determines whether the pathologic changes of necrosis will follow. The direction of the twist is usually clockwise but may be counterclockwise.

There are, however, precipitating causes which must be considered in conjunction with altered anatomy and physiology. Pratt and Fallis stressed the belief, from their research on the subject, that extremes in diet and physical exertion should be seriously considered when there is an abnormal development of the intestinal tract. The higher pro-

portion of cases in Finland and Russia, where the diet consists mostly of potatoes and bread, helps to substantiate the theory that undigested, coarse, vegetable fibers act as an irritant to the colon, which is essentially a cesspool, and that as a result abnormal peristalsis is produced.

Cabot remarked that "for some unknown reason, twists occur much more frequently in those cases whose peritoneum has been damaged by a previous operation or inflammation, even when no constricting bands of adhesions can be found." This premise is substantiated by the many cases reviewed by us. Many other exciting causes have been mentioned by various contributors to the literature on this subject, i. e., old scar formations, bands, chronic mesenteric adenitis, former operations, hernias, foreign bodies, mesenteric cysts, fecaliths, chronic intestinal stasis, tumors and pregnancy. Eustis mentioned typhoid fever as being a predisposing factor. Wangensteen stated that volvulus concomitant with carcinomatous obstruction at the flexure does occur.

Roentgenology can be an aid in the diagnosis of this condition but usually only as an adjunct to the various clinical findings. The interpretation of intestinal obstruction is easily made, but to isolate certain segments of the intestinal tract is a different matter. It is well accepted by roentgenologists that if upright or lateral roentgenograms are made fluid levels can usually be seen in almost any type of real ileus but especially in obstruction of the colon. In most cases obstruction of the colon is of the closed loop type, that is, the ileocecal valve remains "competent" and hence there is little or no distention of the small intestine. Furthermore, if only a portion of the colon is distended by gas and a point can be found beyond which the column of gas is absent or greatly diminished, it is highly significant. Sailer pointed out that the cecum appears to be a region of particular accumulation and that there is a somewhat clearer area in the hepatic flexure on retention of bismuth in the cecum for more than twenty-four hours.

Easton described a "new sign" which he explained as follows:

During the course of a barium enema, the column of barium is unable to pass beyond a certain point in the region distal to the cecum, i. e., in the ascending or transverse colon (organic lesions excluded) so that the cecum cannot be properly delineated in its marking by the barium, and when, at the same time, a large collection of gas appears at the site of the cecum, indicating its patency and conformation, either in the midline or slightly to the right of it, this is a clear sign that volvulus of the cecum had taken place.

Rothman suggested the following procedure: Take a roentgenogram on entry of the patient to the hospital and start Wangensteen drainage and enema. Take another roentgenogram and compare; the gas bubble will be in the same position and will have the same configuration. It may possibly be slightly larger, which means a closed loop obstruction;

the size and the fluid level indicate involvement of the colon. From the position, one may diagnose volvulus of the cecum, as sigmoidal volvulus presents a different picture.

The signs and symptoms of a volvulus of the cecum are as a rule bizarre. From observation of our own cases and from the data obtained from a review of the cases which have been analyzed, there is no definite sign or symptom complex. On the other hand, the patient's history and the presence of localized tympany, distention or mass may be of the greatest aid in forming a preoperative diagnosis.

Marnoch laid stress on local tympany and distention. From a study of reported cases he concluded that the less the small intestine is involved the more prominent is this symptom in obstruction of the large bowel. Treves spoke of the irregularity of distention and Wangensteen of the acuteness in volvulus of the cecum or small intestines as compared with torsion of the pelvic colon. According to our observations and those of others, the early absence of abdominal clicks is of importance.

Ingelfinger stated that of 81 patients studied 47 per cent exhibited chronic symptoms before the acute onset. Small stated that in a series of 190 patients with mobile cecum 79 had previously undergone operation for "chronic appendicitis." Chalfant advised that "the diagnosis of torsion of the cecum should be thought of with patients presenting a history of obstinate constipation with previous attacks of severe pain in the upper abdomen." Sweet made the statement that "clinically there are signs of intestinal obstruction with perhaps localized abdominal distention in the right half of the abdomen or the presence of a large tympanitic mass, in this region, suggesting a dilated cecum." Coughlin quoted Coffee, who said: "I am convinced that over one-half of the patients complaining of right sided pain have no definite organic disease but have defective fixation of the ascending colon and that x-ray so often shows a fairly movable cecum and ascending colon." Evans and Bigger, in their recent communication, mentioned the sign of "position of relief," i. e., any position in which the patient is free of his pain, as highly suggestive of obstruction of the bowel.

The abdomen may be silent early; if sounds are present, they are generally of a low pitch. Early shock is infrequent. At times rectal or vaginal examination helps to confirm the diagnosis. Gaseous distention often produces an early and typical tender tympanitic swelling, usually in the right lower quadrant. Before volvulus becomes permanent, it may cause colicky pain in the ileocecal region for one or two days. There are the usual signs of intestinal obstruction, with considerable inflation of this part of the bowel.

In reviewing the data on 100 cases (including 6 of our own), we have attempted to make an analysis based on the following observations.

SUMMARY OF ONE HUNDRED CASES

Age.—The highest incidence occurs in the 25 to 30 age group, with the 20 to 25 age group second, although the average age of the patients is 39.8 years. The appended chart shows the age distribution.

Sex.—From a review of the literature it is apparent that there is little difference in the sex factor. There were 50 men and 50 women.

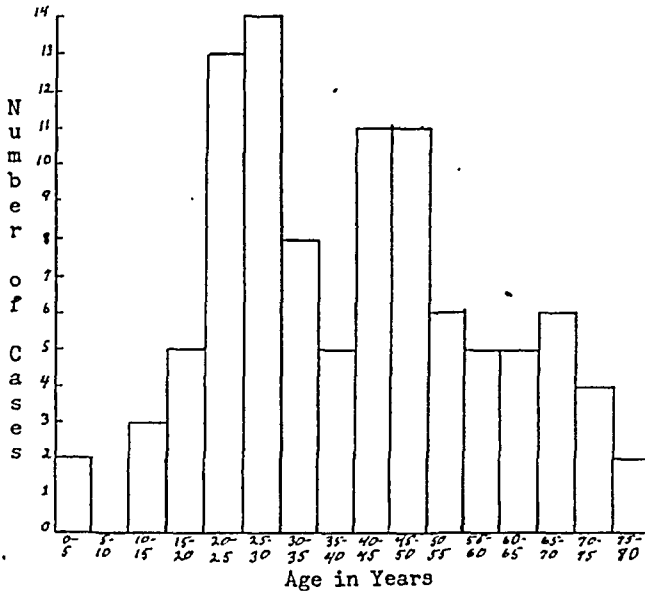


Fig. 1.—Age distribution among 100 patients with volvulus of the cecum.

TABLE 1.—Operations Performed Before Onset of Intestinal Obstruction

No.	Type of Operations	Elapsed Time
3.	Herniorrhaphy (right inguinal area).....	72 hr., 4 yr., 16 mo.
2.	Umbilical herniorrhaphy.....	4 yr., "years ago"
1.	Umbilical herniorrhaphy and cholecystectomy.....	"Years ago"
5.	Appendectomy	7 days, 5 yr., 6 yr., 18 yr. and "years ago"
1.	Appendectomy and gastroenterostomy.....	9 days
1.	Drainage of appendical abscess.....	4 yr.
2.	Cholecystectomy	4 days, 4 yr.
1.	Removal of renal calculus.....	7 yr.
1.	Volvulus of sigmoid (detorsion).....	2 previous detorsions, "years ago"
1.	Cecopexy	5 mo.
2.	"Many abdominal operations".....	"Years ago"
1.	Gastroenterostomy	4 days

Previous History.—Seventy-three patients gave a history of positive symptoms, varying from mild to severe indigestion, or of attacks which were similar but of less severity than the one which caused their admission to the hospital. Practically all in this group complained of constipation. In 19 cases the history was noncontributory, and in 8 the previous history was not mentioned.

Previous Operations.—Operations had been performed before the acute onset of intestinal obstruction in 21 per cent of cases. The types are listed in table 1. The lapses of time between operation and torsion of the cecum were as follows:

Under 10 days.....	5, or 23.8%
Between 1 month and 2 years.....	2, or 9.5%
Between 2 years and 5 years.....	4, or 19.0%
Between 5 years and 10 years.....	2, or 9.5%
Between 10 years and 20 years.....	2, or 9.5%
"Years ago".....	6, or 28.5%

Pregnancy.—In 10 cases the obstruction accompanied pregnancy.

Distention, Nausea and Vomiting.—Practically all patients who gave a complete history had these symptoms.

Rigidity.—Fifteen had rigidity and 11 had no rigidity; in 74 cases rigidity was not mentioned.

Visible Peristalsis.—Visible peristalsis was present in 7 and absent in 13; in 80 cases there was no mention of peristalsis.

TABLE 2.—Types of Operation Performed on Patients With Gangrenous Cecum

No.	Type of Operation	Recovery	Death
10.	Resection.....	4	6
8.	Detorsion and cecostomy.....	3	5
1.	Ileostomy.....	..	1
1.	Died on table.....	..	1
5.	No operation.....	..	5
Total.....		7	18
Mortality (for those operated on).....		65%	
Mortality (no operation).....		100%	

Intestinal Clicks.—Intestinal clicks were present in 16 and absent in 5; in 79 cases no mention of this symptom was made.

Masses.—Masses were present in 29 cases.

Pain.—All patients complained of abdominal pain, but in 51 cases no definite presenting localization was noted. In the remaining 49 cases, the localization was as follows: The epigastrium was involved in 2 cases, the right upper abdominal quadrant in 10, the right lower abdominal quadrant in 17, the periumbilical region in 5, the suprapubic region in 4 and the left lower abdominal quadrant in 2. The pain was diffuse in 9 cases. In 51 cases the pain was reported as colicky at first, and in 5 it was reported as steady at first. In the great majority of cases pain became diffuse within a few hours.

Shock.—Twenty-four patients experienced shock.

Duration of Symptoms.—The duration varied from a few hours to a few days, although many records were so indefinite that a true evaluation could not be made.

Gangrene.—Twenty-five patients presented a gangrenous cecum either at operation or at necropsy. Of these, over 75 per cent came

for treatment before the fifth day. Most of those who survived, however, were operated on within twenty-four hours of the onset of acute symptoms. The data are given in table 2.

The results of operation on patients with and without gangrene are given in table 3.

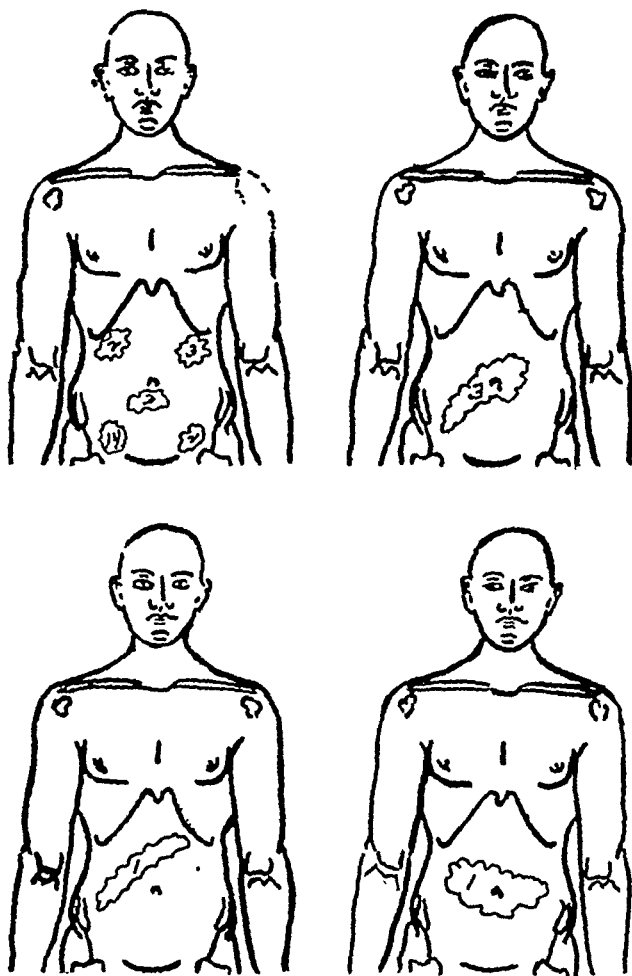


Fig. 2.—Location of masses.

Eighty-three patients were operated on. The type of treatment given to the other 17 patients was not mentioned, but of these, 7 were reported to have died and 3 recovered.

	Number	Recovered	Died
Operated on.....	83	50	23
No operation (excluding those with gangrene).....	2	..	2
Treatment and result not recorded.....	5	?	?
Treatment not recorded.....	10	3	7
Total.....	100	53	42

REPORT OF CASES

CASE 1.—J. E. P. (service of J. L. Donhauser), a 73 year old white man, entered the hospital with the presenting symptom complex of severe persistent pain in the lower part of the abdomen, vomiting and constipation of approximately eighteen hours' duration. For the past four days the patient had not felt well because of difficulty in moving his bowels and some difficulty in passing urine. Approximately eight hours before his admission the abdominal pain increased in severity and became constant in the lower right quadrant, and within a few hours he vomited copious dark green foul-smelling material. During the ensuing few hours he passed a small watery stool containing bright red blood. This alarmed him considerably, and he sought medical aid. About twenty years previously an appendical abscess had been drained, and ten years subsequently a cholecystectomy had been performed.

Physical examination showed a well developed, obese man in partial shock; his respirations were rapid, shallow and grunting, and he was extremely apprehensive. His face was pallid, the lips were cyanotic, the lower extremities were mottled and of a dusky hue and the skin was clammy and cold. The abdomen

TABLE 3.—*Operative Results*

	Recovered	Died
Aspiration.....	1	0
Cecostomy.....	21	13
Cecopexy.....	10	2
Detorsion (alone).....	12	2
Enterostomy.....	0	1
Exteriorization.....	1	3
Exploratory laparotomy.....	0	1
Mikulicz' operation.....	2	0
Resection.....	3	11
Total.....	50, or 60.25%	33, or 39.75%

was full and obese, somewhat distended and slightly irregular. There were no intestinal patterns or waves noted; there was considerable spasm of the entire abdominal wall, but exquisite tenderness and spasm were found in the right lower quadrant. No masses were present and no intestinal clicks audible.

The roentgenographic appearance of the abdomen is given in figure 3.

The patient was operated on under "pentothal sodium" anesthesia within two and one-half hours from the time of his admission to the hospital. A right rectus incision was made. The cecum was found to be huge, about the size of a medicine ball, embedded in diffuse pericecal adhesions and completely gangrenous. It had completely twisted on itself in clockwise fashion. While the volvulus was being untwisted and an attempt made to deliver it, the cecum was ruptured and fecal material covered the operative field. The cecum was deflated, and after a tube was inserted it was exteriorized. Death ensued the following morning. It was interesting to note that at necropsy carcinoma of the hepatic duct and prostate gland was found. There was apparently no relation between the carcinoma and the cecal torsion.

CASE 2.—E. H., an elderly man (service of J. L. Donhauser), entered the hospital because of abdominal discomfort, distention and complete obstipation for seven days. He stated that nine days before he had had colicky pains, especially severe in the right abdominal quadrant, and of a lesser degree in the right lower quadrant. This

pain persisted for two days, after which it became lessened, and it completely subsided after six days. Repeated enemas had been ineffectual, with the exception of the passing of a "little gas." He was nauseated once but did not vomit. The patient's history was noncontributory so far as previous attacks were concerned, but he admitted that years ago he had had "an inflammation of the gallbladder." The bowels had been regular up to two weeks before his admission.

Physical examination showed an extremely thin man who spoke with a hoarse voice and was in apparent distress (discomfort due to abdominal distention). The temperature was 98.6 F., the pulse rate 84, the respirations 24 and the blood

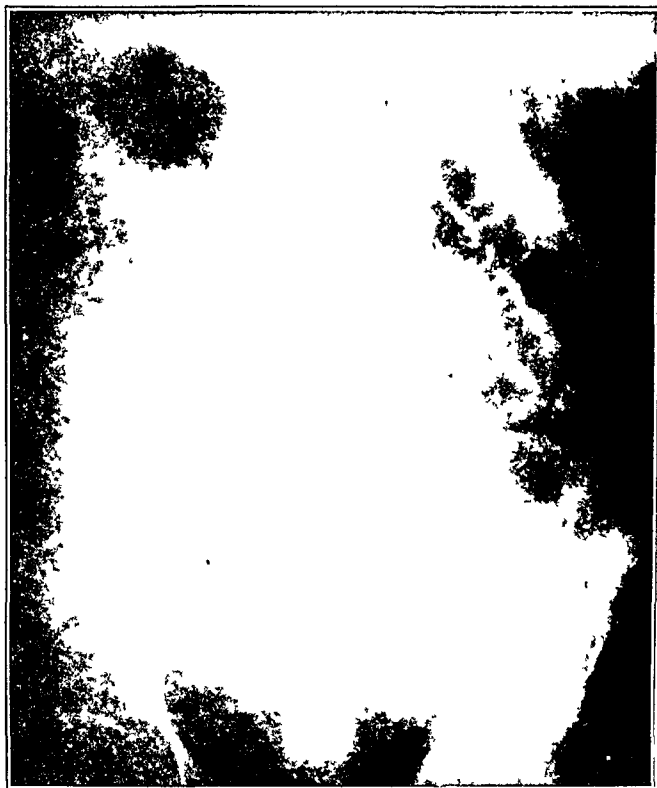


Fig. 3 (case 1).—There are several distended loops of the small bowel to the left of the midline, suggesting intestinal obstruction. A large amount of retained material was visible in the cecum.

pressure 142 systolic and 90 diastolic. The abdomen was much distended and markedly tympanitic throughout. Hepatic dulness was completely absent. The abdomen was symmetric; no peristalsis was noted and no mounds felt. A few indistinct "clicks" were heard scattered over the abdomen. A slight shifting dulness was detected, although there was no definite dulness over the flank. Palpation revealed nothing abnormal with the exception of slight tenderness in the left flank. There was no rigidity.

The roentgenographic appearance is shown in figure 4.

Operative Findings.—When the peritoneum was opened, a small amount of free fluid was encountered. No gas or pus was noted, but there was a tremendous dilatation of the cecum, ascending colon and small intestine. The distal portions

of the transverse colon and descending colon were not dilated. The small bowel was found to be wrapped around the sigmoid and the colon, which were on a long redundant mesentery. However, this did not explain the obstruction. A hard band was found running from the ascending colon to the lateral parietal peritoneum which appeared to be holding up the cecum. This was severed. The cecum was delivered into the wound and found to be dilated to a diameter of about 6 to 8 inches (15 to 20 cm.). Both it and the ascending colon were on a long mesentery and had twisted once on themselves (clockwise). Detorsion was carried out, with recovery.

CASE 3.—Fifteen years before his admission to the hospital J. C. (service of J. L. Donhauser) was operated on for the repair of a hernia in the right inguinal area. Two years later, after an accident, there was a recurrence. A second herniorrhaphy was performed in the usual manner, with a transplantation of the cord. Postoperatively, the patient had considerable distress from persistent abdominal distention, nausea



Fig. 4 (case 2).—*A*, a flat plate roentgenogram of the abdomen shows enormous dilatation of the loops of the small intestine, consistent with obstruction of the small bowel. There is a large accumulation of air in the peritoneal cavity over the dome of the liver on the right side, and there are multiple fluid levels in the small intestine and in the peritoneal cavity. *B*, The findings are consistent with obstruction of the small bowel, with a probable perforation of the viscus, and the free air in the peritoneal cavity may be the result of gas-forming organisms.

and vomiting. This lasted for one week. He gradually improved, though a soft distention still persisted. He complained of abdominal pressure and of considerable gas, but he was able to walk around on the eighteenth day. During this siege, fluoroscopy and a flat plate roentgenogram revealed the presence of "pneumoperitoneum." No etiologic factor could be found to account for this condition, and at that time surgical intervention was not apparently indicated.

One year later the patient was admitted to the hospital because of abdominal pain, nausea and vomiting. The presenting symptom at this time was sharp epigastric pain. From his story, it would appear that he had felt perfectly well until two weeks before his admission, during which time he had "indigestion and stomachache." Two days before his admission sharp epigastric pain with diffuse abdominal radiation occurred and there were several episodes of nausea and vomiting. There had been no evacuation of stools for thirty-six hours. A slight bowel movement was obtained by means of an enema.

Physical examination revealed a fairly well nourished man, 53 years of age, in moderate distress. He looked extremely sick. There was general arteriosclerosis present (Wassermann reaction positive), and on inspection of the abdomen, there was noted a large sausage-shaped area of distention running diagonally across the abdomen from the left upper quadrant to the right lower quadrant and being from 15 to 20 cm. in length. The mass was tense, tender and tympanitic, and there were tenderness and moderate spasm in the right lower quadrant. In the epigastrium slight tenderness was noted. The abdomen was tympanitic throughout. There was no visible peristalsis. On auscultation, intestinal clicks were increased, but no "rushes" were audible. The temperature, pulse and respirations were within normal limits. The blood pressure was 155 systolic and 95 diastolic. The white blood cell count was 92,000. The urine was essentially normal. The blood sugar content was 424 mg. per hundred cubic centimeters, the nonprotein nitrogen 55.4 mg., creatinine 2.1 mg. and chlorides 270 mg.



Fig. 5 (case 3).—*A*, a preliminary roentgenogram showed large accumulation of gas which suggested the stomach in outline. Barium administered by mouth filled the upper portion of the stomach; the latter structure was normal in size and appeared to lie below the gas-containing shadow. There was evidence of a fluid level in the large saclike accumulation of gas, visible when the patient was brought to a vertical position. *B*, a barium enema filled the large intestines up to the splenic flexure, and some of the barium passed into the transverse colon. There was no alteration of the gas pattern described except that it appeared to be smaller in an anteroposterior posture.

The roentgenographic appearances are shown in figures 5 and 6.

The patient was operated on seven and one-half hours after his admission to the hospital. When incision into the peritoneal cavity was made, a large amount of pink-gray fluid escaped. This was evacuated, and it was then noted that a greatly distended deep purple-colored segment of intestine bulged forth and occupied the entire incision. The diameter of this portion of intestine was approximately 15 cm. After slight manipulation, the intestine burst, and fecal material oozed forth. Traction on the cecum revealed it to be completely rotated on itself three times. The ileum to which it was attached had undergone a complete turn. The cecum was untwisted and found to be completely gangrenous. Cecostomy was performed. The patient died from general peritonitis.

CASE 4.—L. T. (service of A. Wallingford), a 38 year old white married woman, was admitted to the hospital because of severe colicky pain in the right upper abdominal quadrant, with vomiting. The patient stated that she had been perfectly well until the evening before her admission. There had been no history of previous attacks. Twelve years ago she had had her appendix removed. The bowel movements had been regular. She was eight months pregnant.

Examination of the abdomen showed an enlargement consistent with an eight months pregnancy. Another enlargement to the right and superior to the uterine fundus (evidently ballooned intestines) was observed. Maximum tenderness with-



Fig. 6 (case 3).—Gangrene of cecum, ileum and mesentery due to torsion facilitated by abnormally mobile ileum and cecum.

out rigidity was noted over the right upper quadrant (upper end of an old scar from an appendical operation). On stethoscopic examination, a clear bell-like tinkle or "peristaltic jingle," suggesting obstruction of a loop of intestine, with jostling of fluid inside, was heard.

The roentgenographic appearance is shown in figure 7.

The patient was operated on nine and one-half hours after her admission to the hospital. At operation, loops of the terminal end of the ileum presented themselves greatly distended with gas. The cecum had made a complete revolution. There were adhesions from the cecum to the upper fold of a loop of the terminal

end of the ileum about 2 feet (61 cm.) from the ileocecal valve. The cecum was extremely mobile after its release. Detorsion cured the condition, and the patient made an uneventful recovery.

CASE 5.—D. B. (service of A. W. Elting), a 23 year old white mechanic, was admitted to the medical service and transferred to the surgical service about one week after the onset of abdominal pain, fever, lethargy and anorexia. The diagnosis, as verified by the laboratory, was typhoid fever. The patient was apparently making an uneventful recovery until the tenth day after his admission, when he awakened early in the morning complaining of abdominal pain. The pulse rate, which had been consistently between 90 and 100, had risen to 130; it then fell to 70. The abdomen became distended and diffusely tender; no spasm could be elicited except



Fig. 7 (case 4).—A flat plate roentgenogram of the abdomen showed considerable distention of the ascending colon and of a portion of the transverse colon. A fetus is visible within the abdomen, in breech presentation.

in the right lower quadrant. It was felt that the patient was suffering from a perforation of the bowel or from hemorrhage.

Examination revealed the following symptoms: The abdomen was somewhat distended and asymmetric, with increased prominence in the lower right abdominal quadrant, particularly marked toward the midline. The costal and iliac grooves were obliterated. Respiratory movements were present in the upper part of the abdomen and practically absent in the lower part. There were no visible patterns. On palpation, there was a definite resistance of the upper abdominal wall, which did not appear to be tender. In the lower part of the abdomen, particularly in the right lower quadrant, resistance was increased and discomfort was pronounced. There was the sensation of a mass behind the abdominal wall occupying the lower median portion of the right quadrant of the abdomen and corresponding to the

asymmetric prominence. This area as well as the rest of the abdomen was tympanitic. Rectal examination showed some accumulation pressing into the pelvis from the right side, which was interpreted as an early peritoneal accumulation or as dilated intestine. The white blood cell count was 5,300.

With the patient under anesthesia produced by gas, oxygen and procaine hydrochloride infiltration, an exploratory laparotomy was performed. A tremendous volvulus of the cecum was found (fig. 8). The bowel was so dis-



Fig. 8 (case 5) —Volvulus of cecum complicating typhoid fever. The anterior wall of the cecum has turned to the right 180 degrees and has carried the terminal ileum with it. The terminal end of the ileum can be seen lying anteriorly and entering it on what is now its right side.

tended that it was impossible to manipulate it, so that after a decompression a cecostomy was performed and the patient returned to his room in fairly good condition. Five days after operation the pulse became of poor quality and the abdomen moderately distended and a bilateral cervical adenitis developed. Within a few hours distinct glossitis developed. The temperature rose to 104 F. A blood culture was taken, which was subsequently reported as showing the presence of hemolytic streptococci. On the sixth day after operation the patient died.

CASE 6.—Mrs. M. L. (service of A. Wallingford) was admitted to the hospital with the chief complaint of pain in the right side of her abdomen, approximately 3 cm. to the right of the umbilicus. The patient stated that she had been perfectly well until six hours before her admission, when pain developed in the abdomen; four hours later she became nauseated, and on her admission to the hospital she vomited. There was no radiation of pain, and she had had a bowel movement eight to ten hours previous to the onset.

Physical examination showed a well developed woman, 43 years of age, in acute distress and complaining of nausea and of abdominal pain. The abdomen was tender and tense just to the right of the umbilicus. No mass could be felt, and there was no visible peristalsis. Peristaltic clicks were accentuated, and borborygmi could be heard. The urine was normal. The white blood cell count was 13,600. The temperature was 99 F., the pulse rate 90 and the respirations 22.

The patient was operated on ten and one-half hours after her admission to the hospital. At operation, a large mass the size of a football was found to be the cecum. After delivery of the cecum, it was seen to be obstructed at a point approximately 20 cm. from its tip and just beneath the hepatic flexure; the cecum had been twisted on itself three times, rotating from right to left. The torsion was untwisted and the appendix removed. Roentgenograms had not been taken. The patient recovered.

An analysis of the signs and symptoms ascertained in this series of 6 cases shows the following:

1. Pain was of a colicky nature in 3 cases and constant in 3 cases, and it was most commonly found, in the beginning at least, in the right upper abdominal quadrant or in the epigastrium.

2. Nausea and vomiting were present in all but 1 case, and in this case extreme nausea was present but no vomiting.

3. In all but 1 case enemas were effectual. This strengthens the idea that fairly good results with enemas may be obtained even though there is an obstruction (low in the bowel).

4. Distention, either symmetric or asymmetric, is a practically constant finding.

5. Abdominal rigidity is not a prominent feature unless gangrene, with or without perforation, has occurred, and abdominal tenderness, generally at least, is over the area of torsion.

6. Roentgenologic evidence is not conclusive, but a careful study of the roentgenograms, if the possibility of torsion is borne in mind, might well lead to a more perfect preoperative diagnosis.

7. Visible peristalsis is not as commonly found as in volvulus of the sigmoid, and in our series this sign was absent in all cases.

8. Operative procedure should be immediate, and the patient should be treated according to the condition found.

9. Shock is present in cases in which gangrene has occurred.

10. Cecal torsion should be considered as a diagnosis when the presenting signs and symptoms are found in the two right abdominal quadrants and when there are roentgenologic signs of cecal distention.

11. A preoperative diagnosis, other than one of intestinal obstruction, may be impossible.

12. The possibility of cecal volvulus should be borne in mind before a diagnosis of acute appendicitis is made.

13. A previous history of indigestion, constipation and mild attacks similar to those present on the patient's admission to the hospital is commonly noted.

SUMMARY BASED ON ONE HUNDRED CASES

Torsion of the cecum may occur at any age, but in 50 per cent of the cases it occurs in patients between the ages of 20 and 45.

It occurs in men and women in equal ratio.

Most patients give a history of previous attacks.

The signs and symptoms usually are those of obstruction of the bowel. Considerable distention and a mass are often present.

Pregnancy, previous operation, high roughage diet, strong catharsis, dietary indiscretions and unusual exertion are some of the predisposing or precipitating factors.

CONCLUSIONS

1. For torsion to occur, there must be hypermobility of the cecum, which is present in 20 per cent of the population, and a fixed point about which the cecum may rotate.

2. Torsion of the cecum, particularly partial torsion, is more frequent than the reported incidence would suggest.

3. It should be considered in cases in which there is pain in the right side together with a long history of constipation and of previous attacks of abdominal pain.

4. If the roentgenogram of the abdomen shows the pattern of obstruction of the small bowel and there is a markedly dilated loop of bowel on the right side, a diagnosis of torsion of the cecum should be considered. If the roentgenogram made after a barium enema shows the column of barium stopping in the hepatic flexure or in the ascending colon, it is further evidence of the existence of this condition.

5. The type of operation performed depends on the conditions encountered and has little effect on the mortality figures, but the earlier the operation, the better the results.

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SITUS INVERSUS WITH ASSOCIATED ABNORMALITIES

Review of the Literature and Report of Three Cases

J. ROBERT JOHNSON, M.D.

CHICAGO

SITUS inversus, less commonly called transposition of viscera or heterotaxia, has been known from ancient times. Aristotle¹ cited 2 cases of transposed organs in animals. Fabricius,² in 1600 A.D., described a case of transposed liver and spleen in a human being. In 1824, Kuchenmeister,¹ first diagnosed situs inversus in a living human being and Vehsemeyer,³ in 1897, demonstrated the condition by roentgen rays. In a review of the literature in 1926, Cleveland⁴ collected 400 cases up to the end of 1924. Larson,⁵ in 1938, estimated there had been 75 additional cases reported up to that time.

In reviewing the literature from 1925 to 1946, inclusive, I found 632 cases of situs inversus, of which there were 515 examples of dextrocardia, 379 instances of situs inversus totalis, 128 persons in whom dextrocardia was known to be the only form of transposition, 41 cases of partial situs inversus, 46 cases involving only the colon, 20 cases involving only the great vessels of the heart, 6 cases involving the stomach alone and 2 cases involving the liver alone. Among the 515 instances of dextrocardia there were undoubtedly a large number of situs inversus partialis or totalis—yet the information given by the various authors was so meager, or the author had so little interest beyond the heart, that no other diagnosis than dextrocardia could be arrived at. Cleveland and I together have collected 1,032 cases from the literature. Since it is undoubtedly true that many other examples of transposition of the viscera are encountered which are not reported,

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2. Lineback, P. E.: An Extraordinary Case of Situs Inversus Totalis, J. A. M. A. **75**:1775 (Dec. 25) 1920.

3. Vehsemeyer: Ein Fall von congenitaler Detiokardie; zugleich ein Beitrag zur Verwerthung der Röntgenstrahlen in Gebiete der inner Medizin, Deutsche med. Wchnschr. **23**:180, 1897.

4. Cleveland, M.: Situs Inversus Viscerum: Anatomic Study, Arch. Surg. **13**:342 (Sept.) 1926.

5. Larson, C. P.: Situs Inversus with Other Congenital Anomalies, Canad. M. A. J. **39**:474, 1938.

the condition must be much more frequent than has been generally supposed.

The frequency of occurrence varies greatly with different authors. Sherk⁶ found situs inversus ten times in 347,000 admissions to the Mayo Clinic in the twelve year period 1910-1922. Willis,⁷ in 1925, found 3 cases in 10,000 admissions to the same institution. LeWald⁸ found 29 examples in 40,000 roentgenologic studies and 1 in 35,000 physical examinations in the United States Army. Rösler⁹ found 3 cases in 22,402 autopsies. Adams and Churchill¹⁰ found 23 instances in 232,112 admissions to the Massachusetts General Hospital. Balfour¹¹ found 51 cases in the Mayo Clinic in a twenty-one year period, 1918 to 1939. Parson¹² found 2 patients with dextrocardia, an anomaly frequently associated with situs inversus totalis, in 15,000 private patients. Cleveland found 1 case in the anatomic laboratory of the Columbia University College of Physicians and Surgeons during a period of forty years, during which about 10,000 subjects had been examined in routine dissection. Thus, the incidence given by different authors varies from 1 in 35,000 to 1 in 1,379. It is apparent that there is a great variability in the frequency of recognition, and possibly of occurrence, of this condition. The figure 1 in 7,467 given by Rösler, as found in 22,402 autopsies, might possibly be accepted as the nearest possible approach to the correct incidence of this condition, with the recognition that autopsies, being performed almost exclusively on hospital personnel, comprise a further selectivity as compared with the general population.

Situs inversus has many variations. While dextrocardia may occur alone, it is most frequently associated with situs inversus.¹³ Many other congenital and acquired lesions of the heart are frequently seen, such as angina pectoris,¹⁴ chronic rheumatic aortic and mitral endo-

6. Sherk, H. H.: Total Transposition of Viscera, *Surg., Gynec. & Obst.* **35**:53, 1922.

7. Willis, B. C.: Appendicitis and Transposition of Viscera, *Ann. Surg.* **82**:256 (Aug.) 1925.

8. LeWald, L. T.: Complete Transposition of Viscera, *J. A. M. A.* **84**:261 (Jan. 24) 1925.

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10. Adams, R., and Churchill, E. O.: Situs Inversus, Sinusitis, Bronchiectasis, *J. Thoracic Surg.* **7**:206, 1937.

11. Balfour, D. C., cited by Wood and Blalock.¹

12. Parson, G. W.: Dextrocardia with Situs Inversus Complicated by Chronic Rheumatic Aortic and Mitral Endocarditis, *Ann. Int. Med.* **23**:102 (July) 1945.

13. Capone, A. J., and Miller, H.: Left-Sided Appendicitis in a Dextrocardiac Patient, *Am. J. Surg.* **71**:282 (Feb.) 1946.

14. Cain, J. C.: Angina Pectoris Associated with Dextrocardia and Situs Inversus, *Am. Heart J.* **30**:202 (Aug.) 1945.

carditis,¹⁵ myocardial infarction,¹⁶ calcareous aortic stenosis and cor bovinum,¹⁷ cor biloculare,¹⁸ persistent truncus (ductus) arteriosus, abnormal systemic and pulmonic veins,¹⁹ arrested cardiac development,²⁰ diverticulum of the heart,²¹ cor triloculare biventriculare,²² transposition of the large vessels of the heart,²³ aortic aneurysm,²⁴ aneurysm of the auriculoventricular septum²⁵ and Roger's disease (congenital defect in interventricular septum).²⁶ The respiratory tract may show such anomalies as transposition of the lungs—three lobes being situated on the left and two on the right⁴—congenital absence of one lung,²⁷ bronchiectasis and absence of or defective development of the paranasal

15. Silberstein, A. G., and Steinberg, I.: Contrast Cardiovascular Study of Patient with Rheumatic Mitral Valvular Disease and Dextrocardia with Complete Situs Inversus, *New York State J. Med.* **43**:1755 (Sept. 15) 1943.

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sinuses. Bronchiectasis, situs inversus and paranasal sinusitis, when occurring together, are referred to as Kartagener's triad,²⁸ 27 cases of which have been reported up to 1937. In the abdomen, transposition may be partial or complete, the latter being the most frequent. Some of the anomalies reported, other than partial or complete transposition, are dextrogastric,²⁹ atresia of the duodenum, polycystic kidney, absence of the spleen or multiple spleens, anomalous lobulations of the spleen, anomalous lobes and lobulations of the liver, including Riedel's lobe,³⁰ isolated situs inversus of the liver,³¹ partial transposition of the upper abdominal viscera (liver, spleen, stomach and duodenum but not colon),³² congenital obliteration of the bile ducts,³³ nonrotation of the colon, partial or total,⁸ megacolon,³⁴ inversion of the colon below the splenic flexure³⁵ and congenital absence of the anus and rectum with a fistulous tract into the prostatic urethra.³⁶ Eighteen cases of cholecystitis associated with situs inversus have been reported up to 1939¹; there have been 3 additional cases reported through 1946.³⁷ Appendicitis has

28. Kartagener, M.: Zur Pathogenese du Bronchiektasien, Beitr. z. Klin. d. Tuberk. **83**:489, 1933. Delp, M. H.: Kartagener's Triad: Situs Inversus, Absent Frontal Sinuses, with Maxillary, Ethmoid, and Sphenoid Infection, and Bronchiectasis, J. Kansas M. Soc. **47**:93, 1946. Richards, W. F.: Situs Inversus Viscerum, Absent Frontal Sinuses with Ethmoid and Maxillary Infection, and Bronchiectasis: Kartagener's Triad; Case, Tubercle **25**:27 (March-April) 1944. Adland, S. A., and Einstein, R. A. J.: Kartagener's Triad: Situs Inversus Viscerum, Bronchiectasis and Paranasal Sinusitis, Am. J. Dis. Child. **61**:1034 (May) 1941. Cole, D. B., and Nalls, W. L.: Situs Inversus, Sinusitis and Bronchiectasis, J. Thoracic Surg. **9**:689 (Aug.) 1940.

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37. Smyth.³³ Rossien, A. X.: Complete Heterotaxia Associated with Obstructive Jaundice, Canad. M. A. J. **46**:572 (June) 1942. Methany, D.; Sherwood, K. K., and Zimmerman, B.: Complete Situs Inversus Associated with Cholelithiasis, West. J. Surg. **50**:254 (May) 1942.

been reported twelve times in the past ten years.³⁸ Transposition may be familial³⁹; it may occur in both of single ovum twins,⁴⁰ in siblings,⁴¹ in newborn infants⁴² and in a dwarf.⁴³ It has been observed in a person having three testicles⁴⁴ and has been associated with such orthopedic anomalies as congenital scoliosis and torticollis,⁴⁵ Köhler's disease and abnormal ossification,⁴⁶ congenital malformation of the vertebral column,⁴⁷ asymmetry of the brain and cranium and spinal curvature,⁴⁸ acrocephaly⁴⁹ and, in a case report submitted later in this article, spina bifida occulta and cervical rib. From the preceding material, it appears that the varieties of transposition are legion, the associated congenital anomalies are numerous and the person with situs inversus is as susceptible to acquired diseases as is one without it.

PATHOLOGIC ANATOMY

Wood and Blalock,¹ in summarizing Cleveland's description and photographic illustrations⁴ of a cadaver with situs inversus totalis subjected to anatomic dissection, gave the following brief, but precise, description of the anatomic arrangements:

The heart lies to the right of the midline, and its chambers are reversed, the apex being the right ventricle, from which arises the aorta. The aorta arches

38. Capone and Miller.¹³ Levering, J. W.: Situs Inversus with Acute Surgical Abdomen, *Clinics* **4**:867 (Oct.) 1945. Prescott, M. U., and Zollinger, R. W.: Appendicitis in Situs Inversus Totalis: Cases, *Am. J. Surg.* **64**:288 (May) 1944. Lawrence, C. W.: Appendicitis with Complete Situs Inversus Viscerum (Case), *J. Kansas M. Soc.* **41**:333 (Aug.) 1940.

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48. Spolidoro, F.: Asymmetry of Brain and Cranium and Spinal Curvature in Case with Complete Transposition, *Sperimentale, Arch. di biol.* **90**:588, 1936.

49. Marcos, J. R., and Mendivil, S.: Acrocephaly and Dextrocardia: Case, *Arch. de pediat. d. Uruguay* **10**:305 (May) 1939.

toward the right, giving off the innominate artery (which subsequently divides into the left common carotid artery and the subclavian artery), the right common carotid artery and the right subclavian artery. The great veins empty into the left atrium, whence the blood passes into the left ventricle, the pulmonary arteries, the pulmonary capillary bed, the pulmonary veins and the right atrium, respectively. The thoracic duct lies to the right and empties into the right subclavian vein near its junction with the internal jugular vein. The lungs are structurally reversed, the right being bilobed and the left trilobed. Intra-abdominally, the cardia lies to the right of the midline and the lesser curvature extends toward the left. The spleen is on the right, and the gallbladder and liver (with reversal of the normal lobular arrangement of the latter), on the left. The entire intestinal tract is reversed, with the cecum and appendix on the left and the sigmoid flexure of the colon in the right iliac fossa.

Partial transposition is known to occur in three main forms, although gradations between the types are so common as to make definite classification difficult. Thus, one may have partial transposition of both the thoracic and the abdominal organs, transposition affecting the abdominal organs alone, or dextrocardia alone.

CAUSE OF SITUS INVERSUS

Adams and Churchill¹⁰ suggested that there may be two main types of persons having transposition of the viscera: first, the true mutant, in which the tendency toward transposition is inherited as a recessive character, the causal elements being in the germ plasm, and, second, the true monster, in which the transposition is the result of external influences acting on the developing embryo. Laboratory experiments on lower animals in which abnormal environmental influences, such as the use of chemical salts, variations in oxygen supply and lowering of the environmental temperature (thus reducing the rate of cellular oxidation), are brought to bear on the embryo, especially in the blastula and morula phases, tend to produce not only transposition, but also other unrelated anomalies. Changes are most likely to be produced when the abnormal environment is experimentally created during a stage in which there are decided inequalities in the rate of cellular proliferation in different parts of the embryo. Any one method may produce all types of monster and, conversely, any type of monstrosity may be produced by a great variety of methods. The end results appear to differ as to degree only, varying from very slight deviations from the normal to a true monster.

The mechanism by which situs inversus is produced in the human being has been explained in many ways. Cleveland⁴ noted three views:

1. The persistence of a right omphalomesenteric vein influencing the shifting of the stomach to the right instead of to the left.
2. The influence of the umbilical cord. In situs inversus it is wound spirally to the right instead of to the left. The blood column flowing in the reverse direction is responsible for the turning of the heart to the opposite side.
3. The turning of the embryo to the right side of the umbilical vessels instead of to the left as it normally does.

DIAGNOSIS

The recognition of situs inversus totalis is based on finding the heart outline to the right of the midline, the apex impulse situated to the right, liver dulness on the left and stomach tympany on the right; in male subjects, the right testicle may be more dependent than the left. The diagnosis is confirmed by a roentgenologic examination of the gastrointestinal tract which shows the stomach to be on the right, duodenum on the left, liver shadow on the left, spleen shadow on the right, cecum and ascending colon on the left and descending and sigmoid colon on the right. Cholecystograms demonstrate a left-sided gall-bladder and biliary tract. Electrocardiographic tracings reveal a total inversion of lead I and transposition of leads II and III.⁵⁰ The observations in situs inversus partialis vary from those of total transposition according to the degree of transposition present. The clue which leads to the ultimate diagnosis of situs inversus is most frequently the observation of dextrocardia. Displacements of the heart to the right may occur as a result of other lesions in the thorax pressing or pulling the heart out of its normal position and may be distinguished from true dextrocardia by means of the electrocardiogram or roentgenogram or by the identification of the displacing lesion. Similarly, a left-sided appendix may be due to an abnormally mobile cecum and must be distinguished from the left-sided appendix due to transposition.

Three cases of situs inversus totalis are reported herewith, 1 of which was associated with endometriosis, a cervical rib and spina bifida occulta.

REPORT OF CASES

CASE 1.—L. R., a 15 year old white school girl, was admitted to Norwegian-American Hospital on Sept. 8, 1946, complaining of pain and tenderness in the lower left abdominal quadrant. She had been quite well until nine months previously, at which time pain and tenderness with occasional nausea started and continued with gradually increasing severity until her admission to the hospital. She had lost about 5 pounds (about 2 Kg.) in the last two months. On September 7, roentgenologic examinations of her chest revealed dextrocardia and of her colon showed the cecum on the left side of the abdomen and the descending colon on the right. The appendix was broad and rather tender to pressure. A complete blood cell count at this time showed no abnormality except for a white cell count of 10,300. There were no complaints other than those given. She was right handed.

50. Waller, A. D.: On the Electromotive Changes Connected with the Beat of the Mammalian Heart and of the Human Heart in Particular, *Phil. Tr. Roy. Soc., London* **180**:169, 1889. Middleton, H. N.: True Congenital Dextrocardia with Situs Inversus Corroborated by Electrocardiographic and X-Ray Findings: *Case, J. Indiana M. A.* **30**:522 (Oct.) 1937. Parsonnet, A. E.: Complete Transposition with Electrocardiographic and X-Ray Studies: *Case, Ann. Int. Med.* **2**:963 (May) 1929. Rimbaud, L.; Serre, H., and Cohen-Tanugi, D.: Clinical, Radiologic and Electrocardiographic Studies on Total Transposition of Viscera, *Montpellier méd.* **21-22**:127 (March-April) 1942.

On physical examination she was observed to be of normal physical development, with no abnormalities except that the heart lay in the dextrocardiac position with the outlines reversed from the normal, the apex impulse being in the fifth interspace in the right midclavicular line. Liver dullness could be percussed on the left side, stomach tympany on the right and the liver edge felt at the costal margin on deep inspiration. The abdomen was tender and very slightly rigid in the left lower quadrant. Results of vaginal and rectal examinations were negative, except for some tenderness high in the left side. Results of urinalysis and blood cell count were negative except for a white cell count of 13,000 and a differential count of 62 per cent segmented neutrophils, 8 per cent band cells and 30 per cent lymphocytes. The reaction to the Friedman modification of the Aschheim-Zondek test was negative.

On September 9, with the patient under general anesthesia, through a left paramedian incision, the abdomen was explored: complete situs inversus abdominalis



Fig. 1.—Roentgenogram of the chest, showing dextrocardia.

was seen, the liver being situated on the left, the stomach and spleen on the right, the appendix, cecum and ascending colon on the left and the descending and sigmoid colon on the right. The uterine cervix was hard and firm and the fundus uteri soft and somewhat boggy. The appendix was thick walled and fibrous, with fibrous adhesions to the serosa. A cyst in the left ovary measured 2 by 2 by 1 cm. in diameter and microscopically showed the characteristics of a corpus luteum cyst. The appendix and the cyst in the ovary were removed and the abdomen closed.

The patient was ambulatory on the fourth day and went home on the sixth postoperative day. She had remained well up to this writing.

CASE 2.—L. F., a 27 year old white housewife, was admitted to the Hospital of St. Anthony de Padua on Sept. 7, 1947, complaining of pain in the lower part of the abdomen.

About ten days prior to admission she felt as though she were "catching cold"; she sneezed, and a severe pain suddenly occurred in the lower part of the abdomen, which persisted with increasing severity. It was diffuse and was aggravated by pressure and by urination. Since that time she had sharply restricted her food intake, because of the pain it caused. Three days before admission there was superimposed a diffuse pain or pressure sensation in the upper part of the abdomen, which radiated into the chest and both axillas, and, concurrently, though she previously had been habitually constipated, her bowel movement became loose. She had lost 7 pounds (about 3 Kg.) in the two months prior to admission.

Her health had been good until the onset of the present illness. A fractured patella, incurred eight months previously, had healed uneventfully. Three normal full term pregnancies had ended with normal spontaneous deliveries, the last of May 8. She had menstruated in July and August, with somewhat excessive



Fig. 2.—Roentgenogram showing the left cervical rib.

quantities on each occasion. A milky vaginal discharge followed the menses of August 24 and continued without change. She was right handed and was unaware of any congenital abnormalities among her blood relatives.

Complete physical examination disclosed no abnormalities except as follows: The teeth were badly decayed. Diaphragmatic excursions were diminished on both sides, and breath sounds were normal but diminished in volume. The heart was outlined to the right of the midline, and of normal size and shape, the apex impulse being in the right fifth intercostal space in the midclavicular line. Abdominal observations were moderate distention, more decided below the umbilicus, tympany in the right hypochondrium and dullness in the left, tenderness without rigidity in the lower part of the abdomen, normal peristaltic sounds and no signs of intraperitoneal fluid or mass.

Vaginal examination disclosed low grade cervicitis (erosion) in a transversely lacerated cervix, which was located in the anterior portion of the pelvic cavity.

There was limited mobility of the fundus uteri, which was in the cul-de-sac. There was decided, but not exquisite, tenderness and a sensation of increased resistance in both adnexal areas. Pain and muscle guarding prevented very deep palpation. Results of rectal and proctoscopic examinations were negative to a distance of 15 cm. from the anus.

A complete blood cell count revealed 11,600 white blood cells as the only noteworthy observation. No abnormalities were observed on examination of the urine.



Fig. 3.—Roentgenogram of the gastrointestinal tract, with stomach, small intestines and colon simultaneously filled with barium sulfate for better demonstration. The cardia lies to the right of the midline, with the lesser curvature directed to the left. The duodenum, cecum and ascending colon are on the left and the descending colon and sigmoid on the right.

On September 8, with the patient under ethylene, oxygen and ether anesthesia, operation was performed. A midline incision from the symphysis pubis to the umbilicus was made and the abdomen opened and explored. Complete transposition of all the abdominal organs was seen. The liver was on the left, the stomach and spleen on the right and the pylorus and duodenum were to the left of the midline; the head of the pancreas was felt to the left of the vertebral column; the

cecum and appendix were on the left and the descending and sigmoid colon on the right.

The entire pelvis was matted with adhesions, some of which were old and puckered up from scarring. The fundus uteri was in the cul-de-sac, the size of a two and one-half month embryo, soft and boggy and normal pink. The right ovary measured 5.0 by 8.0 cm., contained many follicular and several endometrial cysts and was densely adherent to the broad ligament along the right side of the uterus, down to the level of the internal os. The left ovary was not remarkable except that its capsule was thick and fibrous. Both fallopian tubes were enlarged, had densely thickened white walls and varied from 1.5 cm. to 2.0 cm. in diameter. The fimbriated extremities of both tubes were densely adherent to adjacent tissues. On the left side of the lower part of the abdomen and pelvis there was a large organized blood clot, with dense fibrous infiltration and firm fibrous adhesions attaching it to the broad ligament, the fimbriated extrem-



Fig. 4.—Roentgenogram of the lumbosacral part of the spine, showing spina bifida occulta of the first sacral segment with a slight rotation to the right of the fifth lumbar vertebra and the first sacral segment.

ity of the left fallopian tube, a portion of the more mobile part of the rectosigmoid, the distal third of the appendix and a portion of the cecum and terminal ileum. Endometrial plaques were growing on all these tissues except the appendix, no deep penetration of the walls of the intestines nor distortion of their continuity being observed. The largest single endometrial implant observed measured 2.5 by 4.5 cm. The tip of the appendix appeared to be lying in a small fibrinous cavity, as though it had at some previous, but not recent, time been involved in a periappendical abscess, the fluid contents of which had since been absorbed.

The adhesions were freed and normal anatomic relationships restored. The appendix was removed and the stump inverted. Both fallopian tubes and ovaries were removed, together with the hematoma on the left. The fundus uteri was

returned to its normal anterior position and anchored to the round ligaments. Bleeding was controlled, peritoneal toilet performed and 100,000 units of penicillin in isotonic sodium chloride solution and 5.0 Gm. of crystalline sulfathiazole were distributed over the operative area. Omentum was used to cover endometrial implants in the ileum and colon and to overlay the pelvic organs. The abdomen was closed without drainage.

The report submitted by the pathologist confirmed the observations.

Shock set in one hour after the onset of the operation, the systolic blood pressure dropping from a preoperative level of 110 mm. of mercury to 73 mm. of mercury. Parenterally administered fluids and a transfusion of 500 cc. of citrated blood brought the systolic blood pressure back to its preoperative level, but not until four hours had elapsed. Parenteral administration of fluids was continued; a second transfusion of 500 cc. of citrated blood was given on September 10. The temperature reached 101 F. on the second postoperative day and returned to normal on the third day. Penicillin therapy, 25,000 units, given



Fig. 5.—Roentgenogram showing the shadow of the liver on the left and the shadow of the spleen on the right.

intramuscularly every three hours, started on admission, was stopped on the fifth postoperative day. Examination of the blood on September 13 showed hemoglobin 10.5 Gm. (67 per cent) and erythrocytes 4,020,000 per cubic centimeter. She was actively moving in bed from the first day, was ambulatory on the fifth day and was discharged from the hospital on the ninth day. On December 5, her hemoglobin had risen to 13.5 Gm. (81 per cent) and her erythrocyte count to 4,050,000 per cubic centimeter.

She menstruated heavily in October, for three days in November, for five days in January and for five days in March, each time profusely, after which menopause was induced by roentgen irradiation.

A roentgenologic study of her chest (fig. 1) showed dextrocardia and a left cervical rib (fig. 2). A similar study of her gastrointestinal tract (fig. 3) demonstrated a complete transposition of the abdominal viscera and a spina bifida occulta of the first sacral segment (fig. 4), with a slight rotation to the right of the fifth lumbar vertebra and the first sacral segment. The shadow of the liver was on the left and the shadow of the spleen on the right (fig. 5). Electro-

cardiograms (fig. 6) disclosed a complete inversion in lead I of all its complexes. Leads II and III were reversed from the normal order. The axis deviation was to the right. The chest leads CF_1 , CF_2 and CF_4 had negative T waves. No significant deviations from the normal were noted; the observations were those of dextrocardia.

CASE 3.—J. S., a 38 year old white milk deliveryman, was referred to Norwegian-American Hospital on Jan. 12, 1948, by Dr. S. T. Bolstead, complaining of "piles," pain on bowel movement and blood-streaked stools for one year. He was treated with injections about one year prior to admission, without much benefit. He stated on admission that his heart was on the right side and his appendix on the left, having been so informed during the course of a physical examination by his physician who, in a personal communication to me,⁵¹ stated that fluoroscopy in 1938 divulged this information and also showed his stomach

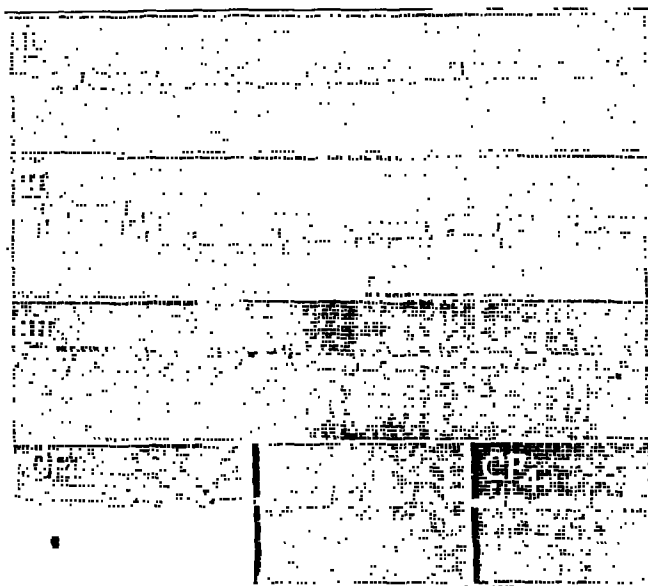


Fig. 6.—Electrocardiogram showing inversion of lead I, reversal of leads II and III and negative T waves in leads CF_1 , CF_2 and CF_4 , with right axis deviation. Essentially observations were normal except for reversal, a characteristic pattern for dextrocardia.

to be on the right side of his abdomen and that inspection disclosed the right testicle to be more dependent than the left. The history and results of physical examination were otherwise negative except that the right border of the heart was in the right midclavicular line, the left border 1 cm. to the left of the sternum and the apex impulse in the sixth right intercostal space in the mid-clavicular line. Examination of the external genitalia demonstrated bilateral varicoceles. Internal and external hemorrhoids were noted. On January 13, a hemorrhoidectomy was performed by the cautery method with the patient under nitrous oxide and ether anesthesia. His postoperative course was uneventful, and he was discharged on January 17 in good condition.

51. Bolstead, S. T.: Personal communication to the author, 1948.

SUMMARY

Situs inversus has been known from antiquity; it is far commoner than has been generally recognized, over 1,000 cases having been recorded; it may possibly occur in the general population as often as, or even more often than, 1 case in 1,379 persons. It varies greatly in the number of organs involved and their degree of involvement, is frequently associated with other congenital anomalies and is at least as frequently associated with any acquired disease as is situs normalis. *Per se*, it is not incompatible with normal health. Transposition is believed to be caused by either a defect in the germ plasm or some deleterious environmental influence acting on the developing embryo.

The recognition of situs inversus can usually be made on physical examination: the heart is situated to the right of the midline; tympany of the stomach is detected on the right and dulness of the liver on the left, and, in male subjects, the right testicle may be more dependent than the left. Electrocardiograms and gastrointestinal roentgenograms confirm and elaborate on the diagnosis.

Three cases of total transposition of the viscera are presented, in 1 of which there were other skeletal anomalies, namely, a cervical rib and spina bifida occulta.

9 South Kedzie Avenue.

EFFECT OF HEPARIN AND PENICILLIN ON EXPERIMENTALLY PRODUCED THROMBOPHLEBITIS

JACOB RABINOVITCH, M.D., C.M.

AND

BERNARD PINES, M.D.

BROOKLYN

EXPERIMENTAL evidence was produced in a previous report¹ to show that heparin would prevent the formation or cause the solution of an intravascular clot. It was also shown that heparin was particularly effective as an anticoagulant when administered to the animal both prior to and immediately after the formation of the clot. Heparin was of no effect when given several days after the formation of the clot, when the latter was partly or completely organized.

The present study was undertaken with the view of determining whether heparin alone, or in combination with penicillin, could bring about the solution of a clot in the presence of experimentally produced, acute thrombophlebitis. It was surmised that the action of the drug would be different in the presence of an acute inflammatory process in the vein than in normal circumstances. Two problems confronted us in this study: first, would the administration of heparin prevent the formation or cause the solution of a locally produced, infected intravascular clot if given prior to or immediately after the formation of the thrombus; and, second, would heparin in combination with penicillin prevent or cause the solution of, such a clot? On this basis, the following experiments were carried out.

PRESENT STUDY

Control Experiments.—In the following series of experiments a clot was produced in the jugular veins of 10 rabbits according to the technic described in a previous communication. Briefly, the procedure may be described as follows: With the animal under ether anesthesia and with a sterile operative technic, an incision was made in the midline of the neck, and both jugular veins were exposed

From the Departments of Surgery and Pathology, Jewish Hospital.

1. Rabinovitch, J., and Pines, B.: The Effect of Heparin on Experimentally Produced Venous Thrombosis, *Surgery* **14**:669, 1943.

and freed from the surrounding tissues for a short distance. The veins were then traumatized by a forcible pull applied at each end of the liberated vein. A localized clot formed almost invariably after such trauma to the vessel. The formation of the clot was further aided by narrowing the lumen of the vessel with a constricting ligature, care being taken not to obliterate the lumen completely, and a free, although retarded, flow of blood being allowed through the narrowed vein.

In the present experiments, in addition to traumatizing the vein, a few drops of a fairly virulent culture of *Staphylococcus aureus* suspended in isotonic solution of sodium chloride were injected into the vessel wall, great caution being taken not to introduce the culture into the lumen of the vessel. The animals were allowed to recover from the operation, and two days later the wound in the neck was reopened and the veins were examined. It was observed at this time that the traumatized veins were acutely inflamed and that the inflammatory process had spread to involve the surrounding soft tissues of the neck. The lumen of the vein in each instance was observed to be occluded with a freshly formed clot, which could be readily palpated, or visualized when the vessel was sectioned. A portion of the vein bearing the clot was removed for further microscopic study.

Microscopic examination of the veins showed the characteristic picture of acute thrombophlebitis. The walls of the vessels were edematous and densely infiltrated with inflammatory cells, particularly polymorphonuclear leukocytes. These cells were often disintegrated and showed conspicuous pyknotic changes. In a number, there was evidence of tiny abscess formation within the vessel wall. The lumen of the veins was occluded with a thrombus, composed of a fibrinous network in which were enmeshed all the cellular constituents of the blood, particularly the polymorphonuclear leukocytes. The unusually large collection of leukocytes in the clot was striking and at once suggested the presence of an acute inflammatory process (fig. 1). Almost invariably, the very same picture was observed in each of the control experiments.

Effect of Heparin.—In the following series of experiments, acute thrombophlebitis of the jugular veins was produced in 6 rabbits according to the technic described for the controls. Two days later, the wound in the neck was reopened and the veins were examined for the presence or absence of thrombophlebitis. When both veins were observed to be thrombosed, a portion of the vein bearing the clot was removed for microscopic examination and served as a control. The constricting ligature was removed from the other vein which was otherwise left undisturbed. The animals were then given daily injections of heparin

in amounts sufficient to keep the circulating blood fluid for a period of five to seven days. At the end of this time the animals were operated on again and the other jugular vein removed and examined.



Fig. 1.—Acute thrombophlebitis, showing acute inflammation of the vessel wall. The lumen of the vein is occluded by a thrombus (control experiment).

Grossly, the vein still presented evidence of an acute inflammatory process, and the lumen was occluded with a thrombus. Microscopically,

the vein presented a typical picture of acute thrombophlebitis, which was indistinguishable from that of the control (fig. 2). The vessel wall was edematous and densely infiltrated with polymorphonuclear leukocytes. Occasional areas of necrosis with miliary abscess formation



Fig 2.—Jugular vein of an animal which received preoperative and post-operative injections of heparin. Note the existence of an acute thrombophlebitis.

were also noted. The lumen of the vessel was completely occluded by an adherent fibrinous clot, which, again, showed a striking predominance of polymorphonuclear leukocytes. It was evident from a study of the

specimens that heparin was entirely ineffective in causing the solution of the clot or in altering its characteristic structure.

Since in these experiments heparin was not administered to the animals until two days after the formation of the clot, it seemed possible that certain changes might have occurred in the clot at this time which caused it not to respond favorably to the anticoagulating effects of the drug. For this reason, an additional series of experiments was carried out with the purpose of administering the heparin immediately after traumatizing the vein and inoculating it with the bacterial culture. Therefore, the heparin was given to the animals prior to the development of the acute thrombophlebitis and for a period of five to seven days thereafter. At the completion of heparin therapy, the animals were operated on again and the veins examined.

Gross examination of the veins revealed the presence of acute thrombophlebitis in each of the 6 animals used in this experiment. The gross observations were also corroborated by microscopic study, which again revealed evidence of acute thrombophlebitis, similar in character and appearance to that noted in the controls. It is evident, therefore, that under these experimental conditions heparin can neither prevent the formation of a thrombus when administered prior to its development nor cause the solution of the clot when given for several days after its formation. It appears, then, that the action of heparin as an anticoagulant in the presence of acute thrombophlebitis is entirely different from that seen in an uninfected clot. We have shown in previous experiments that heparin will prevent the formation of a simple traumatic clot if administered before the clot forms, and that it will cause the solution or disappearance of a similar clot if administered in the early stages of its formation. It is difficult to explain this difference in behavior of heparin under the two experimental conditions unless it is assumed that some, as yet unexplained, factor or factors come into play in the case of acute thrombophlebitis which render heparin ineffective as an anticoagulant, and which are absent in the case of simple traumatic thrombosis.

Effect of Combined Administration of Heparin and Penicillin on Acute Thrombophlebitis.—In the following series of experiments, the animals were given injections of heparin and penicillin, and their combined effect on clot formation was noted. In 12 rabbits, acute thrombophlebitis of the jugular veins was produced according to the technic described for the controls. Immediately prior to the operation, and for a period of seven days thereafter, the animals received daily injections of 200,000 units of penicillin intramuscularly and of heparin intravenously. At the end of this time, the veins were examined. It was then observed that 6 of the animals so treated showed no gross or microscopic evidence of thrombus formation. The vessel wall,



Fig. 3—Jugular vein of an animal which received a combination of heparin and penicillin. Note the absence of clot in the lumen and the presence of an inflammatory process in the vessel wall.

however, was still the seat of an acute inflammatory process, although to a less severe degree than that in the controls (fig. 3). In 2 other animals, the lumen of the vessel was only partially occluded with a loose, retracted clot, which consisted largely of agglutinated erythrocytes, with very little fibrin and few leukocytes. In the remaining 4 animals there was still evidence of acute thrombophlebitis. It is evident, therefore, that the combined action of heparin and penicillin will prevent the formation or cause the solution of an infected thrombus in at least 50 per cent of cases. It may be added, also, that the solution of the thrombus occurs in spite of the fact that the inflammatory process in the vessel wall persists. It is questioned whether a more prolonged administration of the two drugs would eliminate the clot in the remaining cases. Such questions require further investigation.

COMMENT

The results obtained in these experiments demonstrate clearly that heparin will not prevent the formation of an intravascular clot in the presence of an acute inflammatory process in the vein, nor will it cause the solution of such a clot under similar pathologic conditions. It is apparent that some, as yet unexplained, factor or factors come into play in the case of acute thrombophlebitis which render heparin ineffective as an anticoagulant. In previous experiments we demonstrated conclusively that heparin is a potent anticoagulant, capable of preventing the formation of a simple clot if administered to the animal before the clot is allowed to form. Heparin was also shown to cause the solution or disappearance of a thrombus already formed if injected in sufficient quantities in the early stages of the clot formation. This difference in action of heparin on a simple clot and on an inflamed one is striking and of considerable practical significance. These experimental findings suggest that heparin is effective as an anticoagulant in the case of simple phlebothrombosis, but is of no value in the case of acute thrombophlebitis.

The simultaneous administration of heparin and penicillin to animals with acute thrombophlebitis yielded entirely different results. In at least 50 per cent of the animals the combined use of heparin and penicillin either prevented the formation or caused the disappearance of the thrombus. In approximately 16 per cent there was partial solution of the clot, and in the remaining 34 per cent the drug had no effect on the thrombus formation. Of particular interest is the fact that in the animals in which the drugs were effective in causing the solution or disappearance of the thrombus, the vessel wall remained acutely inflamed, although to a less pronounced degree than that seen in the control. The question arises now: How does the combined administration of heparin and penicillin effect the solution of the thrombus?

One of the most interesting facts disclosed in the experimental studies of recent years is the observation made by Nathanson and Liebhold,² who showed that penicillin possesses the unique power of being able to permeate fibrin. On the basis of these experiments and the pathologic observations described, we are inclined to believe that penicillin, when administered, permeates the fibrin in the clot and inhibits the growth and activity of the organisms responsible for the acute thrombophlebitis. Once the bacteria have been rendered inactive by the penicillin, heparin can then act freely in dissolving the clot. Such an assumption will also explain the fact that, although the clot disappears from the lumen of the vein, the vessel wall may remain acutely inflamed. It is also evident that, in order for penicillin to be effective in its action, it must be given in sufficiently large quantities and for a sufficiently long period.

The experimental evidence presented has a practical application, and the importance of these observations requires little comment. Sufficient data have been accumulated from this study, and from those of other investigators, to permit the conclusion that the combined administration of heparin and penicillin will cause the solution or disappearance of a clot in a fairly large number of cases of thrombophlebitis, especially if given in the early stages of the clot formation. Furthermore, heparin alone is of no value in preventing the formation of or in causing the solution of a clot in the presence of acute thrombophlebitis.

SUMMARY

Experimental evidence has been produced to show that heparin is not effective in preventing the formation of or causing the solution of an intravascular clot in the presence of acute thrombophlebitis.

The combined administration of heparin and penicillin will prevent or cause the disappearance of a clot in a large number of subjects with experimentally produced acute thrombophlebitis.

Roche-Organon, Inc., Roche Park, Nutley, N. J., supplied the heparin used in these experiments.

555 Prospect Place.

2. Nathanson, M. H., and Liebhold, R. A.: Diffusion of Sulfonamides and Penicillin into Fibrin, *Proc. Soc. Exper. Biol. & Med.* **62**:83. 1946.

FACTORS CONTRIBUTING TO LOW MORTALITY FROM APPENDECTOMY FOR ACUTE APPENDICITIS

A Ten Year Study

ARTHUR B. MCGRAW, M.D.

DETROIT

IN SPITE of gradual, steady improvement in operative mortality reported by numerous authors, the treatment of acute appendicitis remains one of the most serious and frequent problems confronting the surgeon. The 6,697 persons listed in the latest available United States census reports as dying of appendicitis in this country in 1945 indicate that there is still need for efforts to improve our methods of dealing with this disease and to widen their effective use. As one such effort, the experience of our clinic with acute appendicitis for the ten year period 1938 through 1947 has been reviewed in an effort to seek lessons that may continue to be applied toward holding the mortality rate among patients treated for this disease at or close to the zero point.

CLINICAL MATERIAL

Numbers and Types of Cases.—During the ten years from January 1938 through December 1947, 1,411 patients underwent operation at Henry Ford Hospital, Detroit, for acute appendicitis. For 1,365 patients (97 per cent) the operation was appendectomy. For 46 (3 per cent) it consisted of simple drainage of an appendical abscess without appendectomy. One fourth of the removed appendixes revealed gangrene; 28 per cent of the gangrenous appendixes revealed perforation. These are the laboratory findings, based on gross and microscopic examination.

The over-all hospital mortality for the entire series was 0.64 per cent (9 deaths). All 9 deaths occurred during the first five years of the decade, a mortality rate of 1.1 per cent (824 patients). Among the remaining 587 patients operated on since 1942 the mortality rate was therefore zero. Among the 46 patients who had abscesses drained there were 2 deaths, a ten year mortality rate of 4.4 per cent. Among all 1,365 patients who underwent appendectomy there were 7 deaths,

From the Division of General Surgery, Henry Ford Hospital, Detroit, Mich.

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a ten year mortality rate of 0.5 per cent. These figures are summarized in table 1.

Clinical Findings.—From the standpoint of diagnosis, the incidence and grouping of symptoms, physical signs and laboratory evidence of acute appendicitis in this series of cases showed no important deviation from those long recognized as characteristic of that disease and are here cited only in part and in the briefest fashion.

According to the patients' histories on their admission to the hospital, 31 per cent of them had had previous attacks, and 20 per cent had used cathartics; 75 per cent complained of nausea as an early symptom,

TABLE 1.—*Postoperative Mortality of Acute Appendicitis*

Procedure	Five Years 1938 to 1942			Five Years 1943 to 1947			Ten Years 1938 to 1947		
	Total	Died	%	Total	Died	%	Total	Died	%
All operations.....	824	9	1.1	587	0	0	1,411	9	0.64
Appendectomy.....	806	7	0.9	559	0	0	1,365	7	0.5
Abscess drained.....	18	2	11.0	28	0	0	46	2	4.4

TABLE 2.—*Duration of Symptoms*

Duration	Per Cent of All Cases
Within 12 hr.....	29.0
12 to 24 hr.....	30.5
24 to 36 hr.....	11.5
36 to 48 hr.....	11.5
48 to 60 hr.....	2.0
60 to 72 hr.....	6.2
4 days.....	2.9
5 days.....	2.0
6 days.....	0.5
7 days.....	2.5
Over 7 days.....	1.4

59 per cent of vomiting, 13.5 per cent of diarrhea and 13.8 per cent of constipation. Forty-five per cent had generalized abdominal pain at the onset of their attack, 25 per cent pain confined to the right lower quadrant, 12.5 per cent epigastric pain and 8.5 per cent periumbilical pain. There was a shift of pain to the right lower quadrant in 62 per cent.

The duration of symptoms before admission is shown in table 2.

On examination of the patients on their admission to the hospital, localized tenderness in the right lower quadrant was found in 97 per cent, muscle spasm in 65 per cent and rebound tenderness in 73 per cent.

The total leukocyte count lay between 10,000 and 20,000 in 71 per cent of cases. The relative proportion of counts above and below these figures were approximately equal. The proportion of polymor-

phonuclear leukocytes ranged from 81 to 90 per cent in half the cases. In the other half there was a slight preponderance of lower counts.

Nonfatal Complications.—There were sixty-three nonfatal post-operative complications, recorded under fourteen headings. They represent an incidence of 4.5 per cent and are shown in table 3.

A number of the items in this table require brief comment. The incisional abscesses are those occurring in wounds closed without drainage. They were all small and of short duration. Shallow wound separations without evisceration occurred in 3 cases in which drained McBurney incisions were used and in 1 in which there was a drained transverse incision in the lower abdominal area. An incisional hernia occurred in a case in which a right rectus incision was made and in 12 cases in which drained McBurney incisions were used. All were of the small, buttonhole type. Two fecal fistulas followed inversion, and

TABLE 3.—*Nonfatal Complications*

Complication	Number	Per Cent Incidence
1. Incisional abscesses (all minor).....	12	1.13
2. Wound separations (all small).....	4	0.28
3. Incisional herniae (all small).....	13	3.6*
4. Intra-abdominal abscesses.....	11	0.8
5. Fecal fistulas (nonpersisting).....	3	0.21
6. Pneumonia	8	0.57
7. Atelectasis (massive).....	2	0.14
8. Pulmonary embolus.....	2	0.14
9. Phlebothrombosis (femoral).....	3	0.21
10. Acute parotitis.....	1	0.07
11. Acute pyelitis.....	1	0.07
12. Acute hepatitis.....	1	0.07
13. Empyema thoracis.....	1	0.07
14. Bronchial fistula.....	1	0.07

* This figure was calculated from only the 305 cases in which wound drainage was used.

one followed simple ligation of the appendical stump. All three healed promptly and spontaneously.

Ten postoperative, nonfatal pulmonary complications occurred, an over-all incidence of 0.71 per cent. There were 8 cases of pneumonia and 2 of atelectasis. Inhalation anesthesia was used for eight operations and spinal anesthesia for two, but the incidence figures for the number of times each type was used were nearly equal, 0.69 per cent and 0.79 per cent respectively. We are doubtful if any markedly different choice or distribution of anesthetic agents would have lessened this small number of pulmonary complications.

Postoperative Mortality.—Death followed operation in 9 cases, as shown in table 4.

The 5 deaths from generalized peritonitis were all results of continued overwhelming infection and require no special comment.

The patient with pulmonary embolus, a man of 63, died suddenly on the sixth postoperative day, without warning and apparently of his first embolic episode.

Another elderly man of 64, who gave an antecedent history of myocardial disease, died suddenly on the second postoperative day of symptoms clinically resembling those of coronary occlusion. Permission for autopsy was not obtained.

The presence of Addison's disease in 1 patient was known before the operation for appendicitis with perforation and spreading peritonitis was undertaken. An addisonian crisis developed on the day after operation.

The death from cerebrospinal meningitis occurred actually three years after appendectomy. It was, however, the culmination of a chain of tragic complications so clearly related one to another that it should not be excluded from the mortality list. During the seven weeks of his original stay in the hospital the patient had a pelvic abscess, a sub-phrenic abscess, empyema and a bronchial fistula. Subsequently he required treatment for chronic intraperitoneal abscesses, a renobronchial fistula, pyonephrosis (nephrectomy) and osteomyelitis.

TABLE 4.—*Causes of Postoperative Deaths*

	Following Appendectomy	Following Drainage Only
Generalized peritonitis.....	3	2
Pulmonary embolus.....	1	0
Probable coronary occlusion.....	1	0
Addisonian crisis.....	1	0
Cerebrospinal meningitis.....	1	0
Total.....	7	2

COMMENT

Diagnostic Principles.—Acute appendicitis is so common and so serious a disease that its early recognition places great and pressing responsibility on the surgical consultant. Belief in the slogan, "Never forget to play appendicitis against the field," in the consideration of any acute abdominal disease was shared by all staff surgeons participating in this series of operations and taught each of the many residents working under their supervision. Whatever the time of day or night, no pains were spared or inconvenience avoided in using promptly every help that careful history taking, methodical examination and pertinent laboratory tests could bring to bear on the diagnosis of symptoms or signs by any chance ascribable to appendicitis.

Prompt Operation.—When a diagnosis of acute appendicitis was made, exactly the same attitude motivated a policy of proceeding to operate promptly on all patients judged able to withstand operation, regardless of the presence of perforation. Eighty-eight per cent of the appendectomies were treated as emergencies. In only 12 per cent of the

series was deliberate delay allowed. For the most part, the delay was of only a few hours' duration and was used to combat severe dehydration and/or disturbance of blood chemistry. Expectant treatment of the Ochsner type was used only in 2 per cent of patients, whose debility was of such a degree that it made the risk of immediate operation forbidding. It is believed that consistent adherence to the principle of prompt surgical intervention for acute appendicitis has played an important favorable part in the results of this series of operations and that delay or compromise, for example in favor of chemotherapy, will tend to jeopardize the attainment of equal results in future series of comparable size.

Anesthesia.—Inhalation anesthesia was used in 81.5 per cent of the 1,411 operations and spinal anesthesia (procaine) in 18 per cent. Local anesthesia alone was used only five times in the entire series, and intravenous anesthesia was not used at all. For adults and adolescents, anesthesia was of the gas-oxygen type, with ethylene preferred as the agent. Cyclopropane or ether was often used as a supplement and occasionally as the primary agent. Nitrous oxide was not favored. For children and infants, open drop ether was the anesthetic of choice.

Inhalation anesthetics were administered by trained nurse anesthetists of the operating room staff, each assuming her share in rotation of emergency night duty. Spinal anesthesia was given by the operator or his assistant.

The preference for inhalation anesthesia is attributable to a belief in its somewhat greater safety and range of application rather than to misgivings regarding spinal anesthesia. The use of inhalation anesthesia does not require the oftentimes consuming evaluation of risk demanded by spinal anesthesia, and, with the operative technic used, the greater relaxation obtainable with spinal anesthesia is not indispensable. Furthermore, the recent introduction of safe preparations of curare has brought the degree of relaxation possible under inhalation anesthesia almost to that possible with spinal anesthesia.

The Steps of Operation.—The attitude of this clinic toward appendectomy as toward other operations has been consistently that of the Halsted school of surgery. Although many surgeons participated in these operations, there was a decided uniformity in the incision chosen and in the technical manipulations employed for exposure and removal of the appendix. No single step in the operation originated with us, but a pattern of procedure has been established which we have found adequate for avoiding the pitfalls inherent even in "easy" appendectomies and helpful in surmounting the difficulties so often encountered. We believe that some of the steps are of such great importance for consistent good results that they deserve brief mention.

The McBurney incision was used in 93 per cent of all operations. Of the advantages of this incision which are numerous, important and generally recognized, two deserve special emphasis. One is that the location of the incision and the limited exposure increase the necessity for the most painstaking and accurate preoperative diagnosis. The second is that the same factors of location and size discourage meddlesome manipulation and harmful exploration during operation. In our series it was only occasionally necessary (3.8 per cent of cases) to amplify the exposure of a McBurney incision by means of a Weir (cutting transversely the exposed lateral edge of the rectus fascia) extension.

After the incision, the next point considered of great importance is the method used for identifying and delivering the appendix. As soon as the peritoneum is opened, it is the practice in this clinic first to identify and expose some portion of the cecum and not to feel first for the appendix itself, however tempting the latter procedure may be. As soon as a bit of the cecal wall comes into view, one of its longitudinal muscle bands is used as the invariable and unfailing guide to the base of even the most obscurely buried appendix. If the cecum is reasonably mobile, a free-lying appendix will come into sight and up into the wound without difficulty. If, on the other hand, the cecum is not freely mobile or the appendix is held by adhesions or is in an unusual location, primary identification of the appendical base secures, with minimal intra-abdominal manipulation, that part of the organ which must ultimately be dealt with in the act of removal. To this end, a short length of moistened half-inch (1.27 cm.) cotton tape is passed through the mesoappendix close to the cecum and by gentle traction brings and keeps the cecum under control with minimum trauma. Gentle exploration with the finger and any necessary blunt or sharp dissection can then be carried out methodically from a known point of departure. It is occasionally necessary to mobilize a fixed cecum by incising its lateral peritoneal reflexion for a short distance.

The next step needing emphasis is control of the vessels of the mesoappendix. Mass ligation was discouraged because in the difficult case a slipped or broken ligature may lead to disaster. Instead, individual ligation of the main mesoappendical branches was practiced. This more than any other step in the operation called for the most precise teamwork between operator and assistant.

The next point for emphasis is the method of amputation. Inversion of the appendical stump was practiced in 96 per cent of the appendectomies of this series. In 4 per cent inflammatory indurations of the cecum made inversion impossible. For inversion, a purse-string suture was used and was always placed before the proximal end of the appendix was crushed and ligated. The material of the suture and the method

of its placing were considered matters of prime importance. The preferred material was fine silk on a fine, straight sewing needle or a curved, split-eye needle. The suture commenced and ended on the antimesenteric side of the appendical base. Five bites sufficed, and each bite was aimed to pierce the serosal and muscular coats of the cecum perpendicularly, pick up the tough submucosa but neither enter nor pierce the mucosa. The first and last bites of the suture were not closer than 1 cm., and the purse string surrounded the base of the appendix at the shortest distance permitting inversion in the individual case.

The practice of "walling off" by stuffing Mikulicz or other gauze sponges through the wound into the abdomen was discouraged.

The last point to be mentioned in connection with operation is drainage. Drainage was used in our cases whenever there was grossly recognizable pus in the peritoneal cavity, either free or walled off. The watchword "when in doubt, drain" was accepted. The standard material for drainage was soft rubber dam, sometimes of the "cigaret" type but more often not. Rubber tubing or catheters were never used. Drainage was carried out in 25 per cent of the 1,411 cases. In 22 per cent of the cases drainage accompanied appendectomy, and in 3 per cent drainage alone was employed.

The Operating Surgeon.—One hundred and one surgeons participated in this series of operations, but 16 of them performed two thirds of the operations. Six of the 16 were full time staff surgeons, eight were head residents and two courtesy staff members both of whom had received their surgical training at the hospital. None of the sixteen performed less than twenty-five operations, and half of them performed more than fifty operations. The remaining one third of the operations was distributed among 8 full time staff surgeons, 8 of the courtesy staff and 69 junior residents. It seems of great significance to us not only that the larger portion of the operations were done by a relatively few experienced men but also that every other participating surgeon received his training in the same school of surgical thought and practice and performed his operations according to a rather uniform and consistent pattern of technic.

POSTOPERATIVE TREATMENT

Sulfonamide Compounds and Antibiotics.—Of all the therapeutic agents available during the past ten years as supplements to surgical treatment, the sulfonamide drugs and the antibiotics have been unquestionably the most important. Limited at first, both in availability and variety, they were administered to only 6 of the 320 patients with acute appendicitis seen in the years 1938 and 1939. Thereafter, especially after the development of sulfadiazine, these drugs were used with

increasing frequency until 1943. After that they were used less often, until they were virtually replaced by penicillin in 1947. Twenty-two patients received sulfonamide drugs intraperitoneally as well as by other routes, 46 received them intraperitoneally only and 196 received them only by the oral or the parenteral route. It is clear from a review of the case histories that the sulfonamide drugs were used throughout with discrimination and always with great respect for their potential dangers. Fortunately, no serious adverse effects were encountered.

Penicillin was released for general use only in late autumn of 1945. Nevertheless, it was used in connection with two thirds of the operations done in the last three months of that year and in over half of the 228 operations of 1946-1947. Due to its negligible toxicity and its spectacular efficacy, penicillin has been used with much less restraint than the sulfonamide compounds. Its beneficial effects in seriously ill patients have been too obvious and striking to need detailed description.

The incidence of nonfatal complications before penicillin became available was slightly in excess of that after its use began, 4.8 per cent compared with 3.6 per cent, but the mortality rate had already been zero for two years before penicillin came into use.

Streptomycin, still more recently released for general use, was employed in only 11 cases, all in the year 1947 and each time in conjunction with penicillin. Its additional benefit, though presumed, is not easily demonstrable from those few cases.

Nutrition, Water, Electrolytes and Blood.—The fact that only brief mention is made here of diet, fluid intake and maintenance of electrolyte balance does not in any way discount the great importance which we attach to those factors in postoperative care. Parenterally administered fluids serving various purposes and often blood were freely used when it seemed necessary, but the great majority of patients got along well by simply being given a liquid diet as tolerated during the first twenty-four hours and the regular hospital diet thereafter. Since earlier ambulation has been practiced, nutrition and metabolic balance have become much less of a problem requiring parenteral therapy.

Other Postoperative Medication.—Constant vigilance was observed against the excessive use of narcotics; no routine narcotic orders were allowed. The use of cathartics was avoided. Reliance on beta-hypophamine and neostigmine for the treatment of distention was gradually abandoned in favor of suction.

Suction and Ambulation.—Two aids of a mechanical nature have been of great help in furthering good results. One of these is the continuous aspiration of gastric, duodenal or intestinal contents through a Levin tube according to the method of Wangensteen or by means of the longer Miller-Abbott tube. Although suction was needed in only 100 of the 1,411 cases, the need in those cases for prompt prevention

or relief of distention was vital, and in more than one instance this procedure may well have been a lifesaving measure.

The other aid of a mechanical nature has been early ambulation. Although difficult to assess as a lifesaving measure, its increasing use has lessened morbidity in an interesting and surprising manner. In the entire ten year period only 11 per cent of the patients were allowed up on the first postoperative day, 17.5 per cent by the third day and 65.5 per cent by the seventh day. In 1947, 66 per cent got up on the first day, 86.5 per cent by the third day and 97 per cent by the seventh day. Early ambulation has not only gotten patients up more promptly but has correspondingly reduced the number of days in the hospital after operation. Over the entire period, 40 per cent of the patients were discharged from the hospital in seven days or less after the operation and 83 per cent by the fourteenth day. For the year 1947, the figures were 68 per cent and 90 per cent respectively.

SUMMARY

In a search for factors contributing to a zero mortality rate of acute appendicitis for the last five and one-half years, we have reviewed the 1,411 cases of that disease encountered in our clinic during the past ten years. Data regarding the clinical material, the type of operation used, postoperative care, complications and mortality have been presented and analyzed.

CONCLUSIONS

As a result of this analysis we conclude that in spite of the indisputable help of the sulfonamide and antibiotic drugs the prime factors in the elimination of mortality in acute appendicitis are (1) the alertness with which symptoms and signs of the disease are recognized, (2) the promptness with which the patient is brought to operation after diagnosis and (3) the consistent use of an operative technic which is sound in conception and safe in detail for the difficult as well as for the uncomplicated case.

ABSTRACT OF DISCUSSION

DR. FREDERICK F. BOYCE, New Orleans: Dr. McGraw's incredibly good results contrast with the statistics for acute appendicitis for a recent sixteen year period at the New Orleans Charity Hospital, where, by an erratic but generally progressive decline, the mortality has now fallen to approximately 3 per cent. Rupture continues to take a high toll and abscess is clearly not the desirable eventuality certain communications in the recent literature might suggest.

I question Dr. McGraw's contention that surgical treatment may safely be postponed for a walled-off abscess. An unruptured, appendix wrapped in omentum sometimes masquerades under that guise. Moreover, a walled-off abscess may rupture intraperitoneally. There were 4 deaths from that accident in the Charity Hospital series.

I also question Dr. McGraw's emphasis on the McBurney incision as an important factor in his excellent results. My own feeling is that details of

technic have little influence on the mortality. At the New Orleans Charity Hospital the lowest mortality was with the transverse incision. With this exception, incisions other than the McBurney were used chiefly in delayed, complicated and diagnostically difficult cases, groups in which the mortality would naturally be higher. The mortality of the various surgical procedures was, as always, an index of the severity of the pathologic process, not of the value of the operation.

For several reasons, the mortality at the New Orleans Charity Hospital is higher than at the Henry Ford Hospital. Our patients are all indigent and often ignorant. Negroes, who accounted for only 28 per cent of the cases of acute appendicitis, accounted for 42 per cent of the deaths. The mortality in the upper age brackets is still appallingly high. Most important of all, even in recent years more than half of all patients were not seen until twenty-four hours or more after the onset of illness. These considerations explain why 1 in every 4 appendixes was ruptured at Charity Hospital, against 1 in every 16 at the Henry Ford Hospital.

The present Reginald Fitz suggested that contributions on acute appendicitis, such as his father's original contribution, be read before medical, not surgical, groups, since the physician, not the surgeon, usually sees the patient first and thus controls his surgical destiny. The great John B. Murphy is said to have devoted part of every day to denouncing delay in the diagnosis and treatment of this disease. The universal application of those two concepts would go far toward solving the problem of acute appendicitis.

DR. M. M. ZINNINGER, Cincinnati: I wish to congratulate Dr. McGraw on the excellent results that he and his associates at the Henry Ford Hospital achieved in the treatment of acute appendicitis. These results could have been attained only by the careful application of sound, fundamental surgical principles. Of these I should like to point out three which I believe are most important: (1) prompt operation as soon as the diagnosis of appendicitis is made, unless the condition of the patient precludes immediate operation; (2) the use of the McBurney incision, and (3) inversion of the appendical stump. My preference is for inhalation anesthesia, but in the Cincinnati General Hospital series in which a fair proportion of the patients operated on were under spinal anesthesia, there is no evidence that the morbidity or mortality was significantly altered by either type of agent.

While our mortality statistics are much higher than Dr. McGraw's, it should be remembered that they come from a large municipal charity hospital and not a private hospital. The mortality rate has been progressively lowered, and I should like to give you an explanation for the reduction. The first period, from 1915 to 1922, was before the establishment of a resident training system; often there was some delay in getting a staff surgeon to see or operate on a patient. In addition, the right rectus was the incision of choice during those years. With the development of a resident training system, prompt operation through a McBurney incision became the routine procedure. This, I believe, explains the drop in mortality from 9.5 to 5.4 per cent for the periods 1915 to 1921 and 1922 to 1933, respectively.

From 1922 until the present, the operative principles employed have not changed significantly and are essentially the same as those Dr. McGraw described, so that other explanations for the lowered mortality rate must be found. One of the most important, I believe, was education of the people of Cincinnati to come to the hospital earlier for the treatment of appendicitis. For example, for the period 1915 to 1933, the average elapsed time from onset of symptoms till the patient reached the hospital was approximately ninety-one hours (nearly four

days), and 42.5 per cent of the patients had perforation of the appendix when they reached the hospital. In the next five year period, the average elapsed time decreased from ninety-one to fifty-eight hours and the incidence of perforation from 42.5 to 36 per cent. In the period 1939 to 1943, a further drop to fifty-four hours elapsed time and to 30 per cent perforations occurred. This change was brought about by an intensive educational campaign carried out by the Public Health Federation and the Academy of Medicine, and was observed in all Cincinnati hospitals.

Significant improvements in management also occurred during these years and, in my opinion, the most important in reducing mortality were (1) the introduction of continuous gastric suction by Wangensteen's method in the middle thirties, (2) improvements in anesthetic methods and use of new anesthetic agents and (3) increased use of blood transfusion and other parenterally administered supportive therapy, before and after operation.

The second slide shows a rather striking reduction in mortality which I believe can be accounted for only by the introduction of chemotherapeutic and antibiotic agents, principally penicillin and, more recently, streptomycin. While sulfanilamide compounds caused some change, the striking reduction seems to have come in 1945 when penicillin first became freely available.

DR. J. L. CROOK, Jackson, Tenn.: In my presidential address delivered before the Southern Medical Association at Hot Springs, Ark., twenty-seven years ago, I said that I believed the highest type of service which the medical profession can render to the public is education of the public.

In my section of the country operations that were done late were almost the only ones in which mortality resulted. My first appendectomy outside of a hospital was performed fifty years ago. It took me all day to get to the place where I was to operate, which was 40 miles from the railroad on the banks of the Tennessee River. My operating table was three planks from the barnyard laid on a kitchen table and a barrel. That patient got well, and I saw him thirty years afterward in Jackson. He recognized me and introduced himself.

The point I wish to make is that the use of purgatives and delay in operation are the two factors responsible for mortality. It is on these two points that education is sorely needed, for both delay and the use of purgatives are due to ignorance. If the public could only be educated to the fact that appendicitis is primarily and entirely a surgical disease and that the patients' lives depend on prompt appearance at a good hospital with an able and conscientious surgeon in charge, mortality would be almost entirely eliminated.

DR. ARTHUR B. MCGRAW, Detroit: I wish to thank all three discussants for their remarks, and particularly for their emphasis on the importance of lay education. We at Henry Ford Hospital are quite aware of that need, though it was not possible in the limited time to deal with that factor.

There is another matter I should like to mention. I want to make it completely clear that the results here reported with regard to mortality in this disease do not in any sense represent solely a personal achievement. These results were possible because of consistent group effort by the entire staff of the division of general surgery, and of a rather large number of young resident surgeons.

UNFAVORABLE REACTIONS TO OXIDIZED CELLULOSE (OXYCEL) IN THE BED OF THE GALLBLADDER

The "Retained Oxycel Sponge Syndrome"

EDWARD S. VANDERHOOF, M.D.

AND

K. ALVIN MERENDINO, M.D.

MINNEAPOLIS

SINCE the early work on oxidized cellulose by Yackel and Kenyon¹ in 1941, repeated experiments have been conducted on laboratory animals in order to evaluate its hemostatic action, absorbability, and the reaction of tissues to it. Putnam² embedded small pieces of oxidized cellulose paper in the abdominal muscles of cats and dogs and demonstrated the complete absorption of the material in most cases. He also implanted pieces of oxidized cellulose gauze in the folds of the omentum in dogs. Examination after eleven days revealed a thickening of the omentum, but microscopic study demonstrated a minimal inflammatory reaction and the complete resolution of the gauze. Uihlein and others³ conducted studies which indicated that a complete dissolution of the oxidized gauze occurred in four and a half days when it was placed in human surgical wounds. Oxidized cellulose was packed into experimentally produced lacerations of dog's liver, kidney and spleen by Frantz.⁴ In each instance the bleeding was satisfactorily controlled.

Dr. Vanderhoof is a Fellow in Surgery at Ancker Hospital, Saint Paul, Minn., under the auspices of the Kellogg Foundation Grant of the University of Minnesota.

Dr. Merendino, on Jan. 1, 1949, assumed the duties of Associate Professor of Surgery, University of Washington, Seattle.

From the Department of Surgery, University of Minnesota, Minneapolis, and the Surgical Service of the Ancker Hospital, St. Paul, Minn.

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2. Putnam, T. J.: The Use of Thrombin on Soluble Cellulose in Neurosurgery: Preliminary Note, *Ann. Surg.* **118**:127-129 (July) 1943.

3. Uihlein, A.; Clagett, O. T., and Osterberg, A. E.: The Use of Oxidized Cellulose for Hemostasis in Surgical Procedures: Preliminary Report, *Proc. Staff Meet., Mayo Clin.* **20**:29-32 (Jan. 24) 1945. Uihlein, A.; Clagett, O. T.; Osterberg, A. E., and Bennett, W. A.: Absorbable Oxidized Cellulose with Thrombin as a Hemostatic Agent in Surgical Procedures, *Surg., Gynec. & Obst.* **80**:470-472 (May) 1945.

4. Frantz, V. K.: Absorbable Cotton, Paper, and Gauze (Oxidized Cellulose), *Ann. Surg.* **118**:116-126 (July) 1943.

The early clinical use of oxidized cellulose as a hemostatic agent was made in neurosurgery. In some cases thrombin was used in conjunction with oxidized cellulose.² However, it was discovered early that the acid reaction of the oxidized cellulose inactivated the thrombin. Neutralization of the carboxyl groups of the cellulose by proper amounts of sodium bicarbonate eliminated the inactivation. Frantz⁵ reported 3 cases in which this material had been used in the control of bleeding from the bed of the gallbladder following cholecystectomy. In the first case drainage was carried out. Healing occurred on the fourteenth postoperative day. In case 2 a biliary fistula persisted from the second to the seventeenth postoperative day. Some bleeding was observed on the ninth postoperative day. The patient in case 3 had an uneventful convalescence.

In view of our own difficulty in 3 of 4 cases in which a single "oxycel" sponge had been left as a permanent hemostatic agent in the bed of the gallbladder after cholecystectomy, we feel that these cases should be recorded, with a word of warning.

PRESENTATION OF CASES AND COMMENT

CASE 1.—C. H., a 29 year old Negro woman, was admitted to the Ancker hospital on June 23, 1947, and readmitted on July 14. She was discharged on July 10, 1947, after the first admission and on August 9, after the second admission.

The patient gave a history of intermittent pain in the right upper quadrant of four years' duration related to the ingestion of fatty foods, cabbage and beer.

A cholecystogram revealed a nonfunctioning gallbladder. A single rounded density was seen in the area of the fundus of the gallbladder, which was thought to represent a stone. A series of gastrointestinal roentgenograms was normal.

On July 2, 1947, a routine cholecystectomy was performed. A large solitary stone was found in the lumen of the gallbladder. After the removal of the gallbladder, a single "oxycel" sponge was placed in the gallbladder bed. A Penrose drain was placed down to the amputated stump of the cystic duct and brought out through a stab wound lateral to the incision. Immediately after operation there was a rise in the patient's temperature to 101.4 F. By the second postoperative day, however, the temperature had returned to normal. The patient was discharged from the hospital on her eighth postoperative day completely ambulatory.

The pathologic report described the presence of chronic cholecystitis and cholelithiasis.

The drain was removed partially on the day before discharge, and by the twelfth postoperative day it was completely out.

Four days after her discharge the patient was readmitted to the hospital complaining of pain in the right upper quadrant and in the back, vomiting and weakness. The temperature was 101.4 F., and the leukocyte count was 11,800, with 86 per cent polymorphonuclear cells. A large area of induration developed on the patient's right side, extending from the costal margin to the iliac crest. A subcutaneous infection was suspected. Therefore, a small incision was made lateral to the

5. Frantz, V. K.; Clarke, H. T., and Lattes, R.: Hemostasis and Absorbable Gauze, *Ann. Surg.* **120**:181-199 (Aug.) 1944.

original incision. No pus was encountered. Subsequently, a fluoroscopic examination demonstrated both diaphragms to be moving well with respirations. A small amount of fluid in the right side of the chest obliterated the costophrenic angle. A flat plate roentgenogram of the abdomen revealed loculated small pockets of air in the subhepatic space.

On July 28 the patient's abdomen was reexplored. In view of the presence of fluid in the right side of the chest, the right subdiaphragmatic suprahepatic space was explored extraperitoneally. It was found to be normal. The incision through the Clairmont approach was closed and a separate incision made over the subhepatic area. A large abscess was encountered and drained. Approximately 400 cc. of chocolate-colored pus were obtained. Fragments of "oxycel" and of necrotic tissue were seen in the material from the abscess. The drains were removed by the eleventh day. The patient was discharged with all wounds healed and has remained well.

Bacteriologic studies of the material from the subhepatic abscess revealed nonhemolytic streptococci, nonhemolytic staphylococci and gram-positive cocci in pairs.

CASE 2.—Mrs. A. M. W., a 25 year old white woman, was admitted to the Ancker hospital on Dec. 6, 1946, and readmitted on Dec. 23, 1946. She was

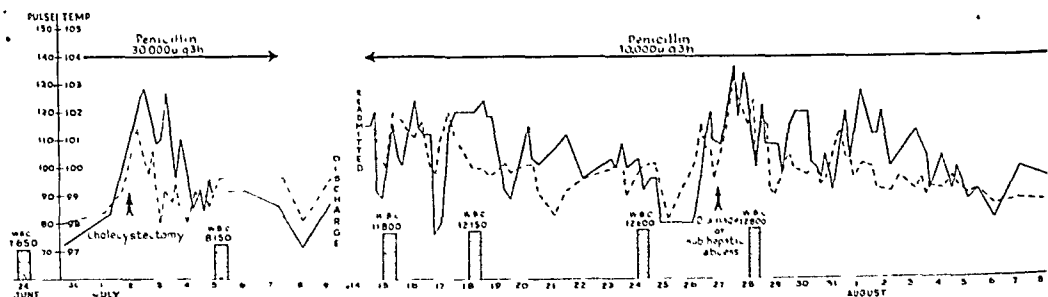


Fig. 1 (case 1).—The cholecystectomy was performed with ease. There was no spillage at the time of operation. The pathologist's diagnosis was chronic cholecystitis with stones. Shortly after the patient's discharge from the hospital there was a recurrence of pain in the right upper quadrant, sufficiently severe to necessitate rehospitalization. After drainage of a subhepatic abscess, the patient progressed to complete recovery.

discharged on December 19, 1946, after the first admission and on December 30 after the second admission.

The history revealed that the patient had suffered from repeated gallbladder attacks since 1944. These attacks were characterized by epigastric pain following the ingestion of fatty foods. One week previous to her admission, she noted clay-colored stools and dark urine. However, no jaundice was evident on her entry to the hospital.

Cholecystogram revealed a nonfunctioning gallbladder. A series of gastrointestinal roentgenograms was normal.

On Dec. 13, 1946, an exploratory laparotomy was performed. The wall of the gallbladder was thickened slightly, and numerous stones could be easily palpated. A cholecystectomy was performed in a retrograde fashion, without event. One "oxycel" sponge was sutured into the bed of the gallbladder by means of surgical gut. A single Penrose drain was laid down to the site of the amputated cystic stump and was brought out through a stab wound in the right upper quadrant.

The immediate postoperative course was uneventful, and the patient was discharged, ambulatory, on her sixth postoperative day.

The pathologic report described the presence of acute and chronic cholecystitis, and cholelithiasis.

The gradual removal of the Penrose drain was begun in the outpatient department on the seventh postoperative day and was completed on Dec. 23, 1946.

Four days after her discharge the patient was readmitted with fever and with severe pain in the right upper quadrant. There was resistance to palpation in this area, as well as tenderness and rebound tenderness. Roentgenograms of the chest showed no evidence of pneumonitis. Examination of the urine revealed it to be normal. With penicillin therapy and rest in bed the temperature subsided and the pain gradually disappeared. The patient was discharged one week after her second admission. She has remained symptom free.

CASE 3.—Mrs. O. L. P., a 67 year old white woman, was admitted to the hospital on Feb. 18, 1947, and discharged on April 4. She was admitted initially to the medical service with cardiac failure. Digitalization controlled this difficulty in a satisfactory manner. While on the medical service a series of gastrointestinal roentgenograms and a gastroscopic examination revealed a gastric

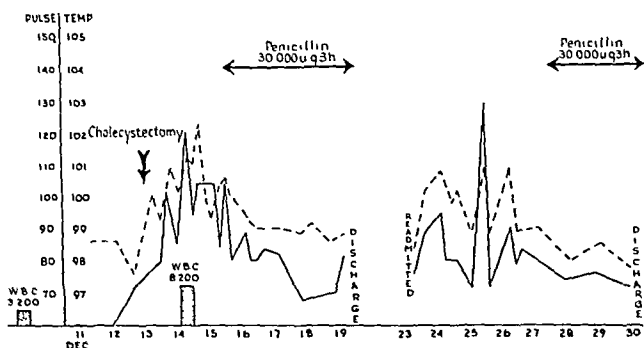


Fig. 2 (case 2).—After an uneventful cholecystectomy, the patient was discharged, ambulatory, on the sixth postoperative day. Four days after her discharge she was readmitted with symptoms similar to those which she experienced during her previous gallbladder attacks. The physical signs present suggested an acute inflammatory process in the right upper quadrant. It is possible that the use of penicillin averted the development of a surgical abscess.

ulcer on the lesser curvature of the stomach, which was considered to be malignant. Numerous radiopaque stones could be seen in the region of the gallbladder at the time of the gastrointestinal examination.

On March 15, 1947, exploration was carried out through a subcostal incision on the left side. An area of induration was found on the lesser curvature of the stomach at the incisura angularis. Consequently, resection of 75 per cent of the stomach was carried out. The gallbladder, which appeared to be normal except for the evidence of numerous stones on palpation, was removed in a retrograde fashion, without event. One "oxycel" sponge was left in situ. The area was drained with a single Penrose drain, which was brought out through a separate stab wound.

The pathologic report described the presence of chronic cholecystitis, cholelithiasis and benign gastric ulcer.

The postoperative course was uneventful until the seventh postoperative day, when the temperature rose to 101.4 F. It subsided in three days after the Penrose

drain began to draw off copious quantities of a yellowish fluid, which was not bile. This drainage persisted for but a few days, and the wound then healed completely after the gradual removal of the drain. There have been no subsequent symptoms referable to the operation.

It is interesting that in the initial case (case 2) the patient was symptomless and afebrile at the time of her discharge following the cholecystectomy. On her readmission to the hospital, however, her complaints were similar in most respects to those which she related at the time of her first admission, but they were of greater severity. With conservative management and the administration of penicillin,



Fig. 3.—Sections of the material from the abscess show it to be composed of acute inflammatory cells together with masses of pink-staining homogenous foreign material, the character of which cannot be determined from the microscopic examination. There is no evidence of foreign body giant cells. The diagnosis was foreign material in an abscess cavity (Dr. John F. Noble). This pink-staining homogenous material undoubtedly represents fragments of the "oxycel" sponge identified on gross examination.

the symptoms and signs gradually abated (fig. 2). It was felt at this time that the patient's difficulty was directly related to the implanted "oxycel" sponge. Consequently, it was decided to treat additional patients in a similar fashion in order to evaluate this impression more accurately. Case 3 involves a patient in whom the cholecystectomy was incidental to a more serious operative procedure. The gallbladder was undoubtedly quiescent. Although a gastric resection was performed at the same time, an aseptic closed anastomosis was carried

out, without contamination. The lesion was a gastric ulcer, and consequently the duodenal stump was inverted aseptically, without event. The rise in the temperature on the seventh postoperative day, followed by a profuse serous drainage, suggested a reaction of the tissue adjacent to the "oxycel" sponge.

In case 1 the severest complication was encountered. The similarity of the sequence of events between this case and case 2 is striking, viz., an uncomplicated immediate postoperative convalescence followed by discharge from the hospital and then a short interval of quiescence, with the subsequent recurrence of pain in the right upper quadrant. Both patients required rehospitalization (fig. 1). There was some delay in establishing the correct diagnosis at the time of the second admission of the patient in case 1. However, the correct diagnosis was made preoperatively. The presence of fluid in the right side of the chest suggested the possibility of a concomitant subdiaphragmatic infection. This was considered unlikely. Nevertheless, the right subdiaphragmatic suprahepatic space was explored first in order to insure a clean operative site. After this area was found to be normal, as anticipated, the incision was closed. A separate incision was made then over the subhepatic area. A markedly indurated mass was palpated and ruptured. The fragments, some rather large, of the "oxycel" sponge together with pieces of necrotic tissue were found in the abscess. Undoubtedly, the sponge represented the nidus for the infection itself (fig. 3). It is unlikely that the sponge was contaminated prior to its insertion.

In the 3 cases in which unfavorable reactions have been encountered the signs and symptoms have become manifest between the seventh and the twelfth postoperative day. The patients have presented a characteristic picture. The symptoms and signs have been more severe than one encounters with some of the ordinary complications following cholecystectomy. Pain has been an outstanding feature of this clinical picture. In fact, the house staff had become so sensitized to the sequence of events that the last patient (case 1) was admitted to the hospital with the diagnosis of "possible retained oxycel sponge syndrome."

SUMMARY

The pertinent literature on oxidized cellulose, "oxycel," has been reviewed. Only 3 cases have been recorded in the literature in which oxidized cellulose has been implanted in the bed of the gallbladder and left in situ. No unfavorable reaction was noted which could be attributed to the effect of this material. We have treated 4 patients in this fashion, 3 of whom reacted unfavorably. The most severe

complication was the development of a subhepatic abscess, which necessitated surgical drainage. Because of this experience with oxidized cellulose left in situ as a means of controlling the bleeding from the bed of the gallbladder, we feel that the material should not be used as a "permanent" hemostatic agent for such a purpose. Furthermore, one should thoughtfully consider the wisdom of similarly implanting this material anywhere in the abdominal or thoracic cavity.

PROGRESS IN ORTHOPEDIC SURGERY FOR 1946

A Review Prepared by an Editorial Board of the American Academy
of Orthopaedic Surgeons

IX. INFECTIONS OF THE BONES AND JOINTS

Prepared by

PHILIP LEWIN, M.D., CHICAGO

Silly Names for Penicillin Products.—In February 1946 The Journal of the American Medical Association³⁶¹ called attention editorially to a great variety of names for penicillin that had been introduced by manufacturers and purveyors. So many names had been offered that they seemed designed to conceal rather than reveal the nature of the product. Now come other titles that fail to indicate the nature of the product but which suggest the section of the body, or the animal, at which they are aimed, or that are otherwise as ridiculous. Here are a few samples from recent lists:

Buffecillin (Pfizer)	Poultrycillin (Schenley)
Crysticillin (Squibb)	Powdalator (Abbott)
Dairycillin (Schenley)	Wycillin (Wyeth)
Duracillin (Lilly)	Capicillin (Barron Chemical Corp.)
Flo-Cillin (Bristol Laboratories)	Denticillin (Marlo Laboratories)
Gelu-Cillin (Warner)	Nasocillin (Mo-La Laboratories)
Hypercillin (Cutter)	Ophlocillin (Marlo Laboratories)
Intracillin (Warner)	Rectocillin (Mo-La Laboratories)
Par-Pen (Smith, Kline & French)	Salvacillin (Barron Chemical Corp.)
Pecticillin (Kline)	Tablicillin (Barron Chemical Corp.)
Pelvicin (Schenley)	Trochicillin (Marlo Laboratories)
Pen-Troche (Cutter)	Vagicillin (Marlo Laboratories)
P. O. B. (Cutter)	

To select a rose from such a garden would require a botanist with more basic knowledge of the naming of plants than most physicians possess. Perhaps the blue ribbon should go to either "Poultrycillin" or "Vagicillin." Perhaps the next step will be numbers to correspond with certain entrances or exits of the human body; we may be talking about "cillin no. 1" for the front and "cillin no. 2" for the rear. In a previous editorial, attention was called to the combination of the manufacturer's name with "cillin." Since there were almost thirty manufacturers, that offered almost thirty possibilities. Now the emphasis seems to be inclining toward the port of entry plus "cillin."

*The Clinical Diagnosis, Prognosis and Treatment of Acute Hematogenous Osteomyelitis.*³⁶²—There is a definite trend against early

361. More Silly Names for Penicillin Products, editorial, J. A. M. A. **137**: 1043 (July 17) 1948.

362. Dickson, F. D.: The Clinical Diagnosis, Prognosis and Treatment of Acute Hematogenous Osteomyelitis, J. A. M. A. **127**:212-217 (Jan. 27) 1945.

drainage of the localized bone abscess in hematogenous osteomyelitis. The bacteriostatic effects which the sulfonamide drugs exert seem unquestionably to bring about the disappearance of the constitutional symptoms and control the local bone infection in some cases. These drugs, however, can have no effect on the local bone destruction which has occurred before the infection was brought under control, and the necrotic tissue which results remains as a possibly quiescent unhealed focus in the bone. As long as the roentgen rays reveal definite areas of bone destruction and sequestrum formation, no matter how silent the area may be clinically, the condition cannot be spoken of as cured but only as one which shows a clinical recession with a quiescent bone focus. Such quiescent areas may remain dormant for years and in some cases permanently. However, an examination of a number of patients treated by the administration of the sulfonamides without drainage has shown that in practically all a careful roentgenologic examination revealed persistent areas of bone destruction which are readily differentiated from the surrounding normal bone. Such areas constitute potential sources of trouble in the future. Wilson and McKeever report on 3 patients treated by administration of the sulfonamides without drainage, with subsidence of acute symptoms, for whom several months later drainage was established because of persistent local induration. Thick, soft, hyperplastic bone was encountered, and granulation tissue was found in the medullary canal when drainage was established. Smears and cultures revealed staphylococci. These findings clearly indicate that such quiescent foci harbor dormant bacteria capable of activity.

Treating a bone abscess with sulfonamide drugs and without drainage may result in putting out the fire; but the ashes remain, and only too frequently ashes which have embers likely to be fanned into activity by such breezes as lowered resistance or local trauma to the quiescent area. Dickson's observations have convinced him that sooner or later a large percentage of these quiescent foci become active. Whether penicillin proves to be an agent which, more powerful than the sulfonamide drugs, will completely sterilize such areas of infection only time will tell. Until then the preponderance of evidence is in favor of early drainage of the osseous focus in acute hematogenous osteomyelitis except in the fulminating type with septicemia and pyemia, in which the drainage of a single focus, when there are probably others present, cannot be expected to have any helpful effect but will probably do harm.

Chronic Sclerosing Osteomyelitis.—The patients included in Meyerding's³⁶³ series of 80 cases had an average age of 25 years, appeared to be in good health and were not disabled. The preoperative clinical laboratory findings in the blood and urine were of little value in the diagnosis. Trauma may have been an inciting factor in 31.2 per cent of the cases.

The outstanding symptom was persistent localized pain in 93.8 per cent of cases. In 67.5 per cent of cases this was associated with swelling. The duration of symptoms averaged 1.4 years. Sixty-five per cent of the patients were males. In 92.5 per cent of cases the lesions were located in the lower extremity; 50 per cent occurred in the middle third of the shaft of the long bones, and 90 per cent occurred in the shaft of the tibia or femur. Patients aged from 10 to 30 years comprised 69 per cent.

The roentgenograms revealed dense spindle-shaped cortical regions of sclerosis that involved the shaft of the long bones. Translucent regions, small and round or oval, were often visible. These regions sometimes showed staphylococci on bacteriologic examination of material removed at operation and have been looked on as foci of infection producing the sclerosis.

The treatment recommended is surgical incision, and the results obtained are good.

Treatment of Acute Staphylococcic Osteomyelitis With Penicillin and Without Surgical Operation.—Penicillin therapy without any early surgical procedure was employed in 8 cases of acute hematogenous osteomyelitis, in 6 of which a demonstrable bacteremia was present.³⁶⁴ There were no deaths. Except in 1 case, in which the authors believe treatment was inadequate, the results were uniformly good. Pain, fever and swelling were diminished within a day or two, and steady improvement usually followed.

Roentgenographically, visible changes, with rarefaction and periostitis, occurred in most of the cases regardless of penicillin therapy, but as a rule these lesions healed in a few months. The patients for the most part were clinically well within one to two months. Intensive penicillin treatment over several weeks is advocated by the authors for acute osteomyelitis.

The reporting of these cases is not to be understood as a final recommendation that in every instance of acute osteomyelitis, treatment without operation should be employed. Even if penicillin is given,

363. Meyerding, H. W.: *Chronic Sclerosing Osteomyelitis*, Tr. West. S. A. 52:545-564, 1944.

364. Bloomfield, A. L.; Kirby, W. M. M., and Armstrong, C. D.: *Treatment of Acute Staphylococcic Osteomyelitis With Penicillin and Without Surgical Operation*, Stanford M. Bull. 3:161-175 (Nov.) 1945.

the physician must use his judgment as to the advisability of surgical intervention as well.

Salmonella Osteomyelitis.—Three cases of salmonella infection of bone are reported.³⁶⁵ In all of these a salmonella organism was originally obtained in pure culture, either from the bone focus or from a local abscess, and all subsequent cultures of the wounds revealed only secondary invaders and not the original causative organism. It is possible, therefore, that many atypical cases of chronic osteomyelitis or solitary bone abscesses may be due to salmonella infection. The salmonella organism may be subsequently overgrown by the secondary bacterial invaders, which mask the original causative organism. Cultures of the bone focus at operation or of pus aspirated from a local abscess should be made in every case to determine the initial pathogen.

All of these cases showed a similar clinical picture. There is usually a mild systemic reaction or none. There are only minimal evidences of local inflammation despite the formation of soft tissue abscesses. The bone focus is chronic, and the symptoms may be so mild that they cause little discomfort even over a long period and the lesion may lie dormant for many years. Roentgenograms show a characteristic picture consisting of a well defined rarefaction shadow, with essentially no reaction of the surrounding bone. There is no medullary sclerosis, cortical thickening, periostitis or sequestration, as usually seen in staphylococcic osteomyelitis. There is likewise no atrophy of osseous or soft tissues surrounding the lesion, as is commonly seen in tuberculosis of bone.

Penicillin and sulfadiazine were given, with no demonstrable effect although the therapy was not pushed vigorously. At the time the patients were treated, streptomycin was not available for trial. It appears that primary closure of the wound after operation is not advisable as it usually leads to sinus formation. Saucerization with healing from below was successful in 1 case, whereas cleaning out the local abscess was sufficient in the third case. It is difficult to be sure whether any of the patients are permanently cured, particularly in view of the dormant tendency so characteristic of this condition.

Pneumococcic Arthritis Treated With Penicillin.—Six cases of pneumococcic arthritis due to types I, V, VIII, XII and XXVIII are reported.³⁶⁶ Penicillin was administered intravenously and intramuscularly in 5 patients, 3 of whom also received it intra-articularly.

365. Seidenstein, H.: *Salmonella Osteomyelitis*, Bull. Hosp. Joint Dis. **6**: 126-132 (Oct.) 1945.

366. Bunim, J. J.: *Pneumococcic Arthritis Treated with Penicillin: Report of Six Cases*, M. Clin. North America **30**:584-596 (May) 1946.

Prompt sterilization of the blood stream and subsequent sterilization of the synovial fluid followed. Surgical treatment was not necessary in any instance.

Prognosis as to life is governed not by the arthritis but by the severity of the associated extra-articular infection. Two patients died; 1 died of bacterial endocarditis and the other was in a moribund state fifty-eight hours after admission to the hospital.

The Use of Penicillin in the Treatment of Acute Hematogenous Osteomyelitis in Children.—Twelve cases of acute hematogenous osteomyelitis,³⁶⁷ in children aged 3 to 12 years, have been studied. Penicillin was employed successfully in the treatment of each of the 12 patients. The infection in 10 of the patients treated successfully by penicillin had proved to be resistant to the sulfonamide drugs. Surgical treatment was necessary in 4 of the 12 patients—in 1 for the removal of a small sequestrum and in 3 for the drainage of an abscess after the acute infection had subsided.

Penicillin appears to be a more effective agent in the treatment of acute hematogenous osteomyelitis than any other therapeutic agent. Early use in adequate doses administered at frequent intervals may not only cure the initial infection but may prevent spread to other bones and in a majority of cases may make surgical intervention unnecessary.

If use of penicillin is not started until after a bone has been extensively damaged, with necrosis of segments of cortex, central destruction of bone and cavity formation, late surgical treatment may become necessary.

From the authors' experience in this series of cases, they hazard the suggestion that in children aged 3 to 12 years, acute hematogenous osteomyelitis may be effectively treated if penicillin is administered intramuscularly in doses of 15,000 to 20,000 units each every three hours day and night. After the temperature begins to subside, the size of each dose may be reduced to 10,000 units, but the frequency of dosage must be maintained. When the patient becomes afebrile the dosage may be reduced gradually and discontinued after five days of normal temperature. Recurrences may occur if penicillin is stopped too soon.

While making use of a remarkable chemotherapeutic agent such as penicillin, one must not neglect to use well established principles of medical care, such as the maintenance of the fluid balance of the body through the administration of isotonic sodium chloride solution, glucose, plasma or blood. Splints, plaster casts or traction should be used when they are needed for supporting the diseased bone or to prevent contractures.

367. Compere, E. L.; Schnute, W. J., and Cattell, L. M.: The Use of Penicillin in Treatment of Acute Hematogenous Osteomyelitis in Children: Report of Twelve Consecutive Cases, *Ann. Surg.* **122**:954-962 (Dec.) 1945.

Acute Hematogenous Osteomyelitis Treated With Penicillin.—Thirty patients with acute osteomyelitis have been treated with penicillin in eighteen months.³⁶⁸ Blood culture was positive in 14 cases. Penicillin was first given systemically in a dose of 100,000 units in twenty-four hours. On theoretic grounds this dose was increased in later cases to a maximum of 400,000 units to obtain a concentration which should be bactericidal as well as bacteriostatic. When the infection appeared to be adequately controlled, the dose was reduced to a minimum of 100,000 units in twenty-four hours.

Two well defined groups of patients were distinguished: (1) those admitted before the bone was seriously damaged and before pus had formed and (2) those admitted with an abscess already present.

Group 1 could be treated successfully by systemic administration of penicillin alone, provided the course was sufficiently long and intensive; the condition might resolve without any roentgenographic evidence of bone changes. Seven of 30 (1 in 4) patients admitted were suitable for this treatment. Group 2 must be treated surgically, as well as with penicillin, and surgical treatment must include release of pus in the bone by drilling; after this, primary suture is safe and advisable to prevent secondary infection.

Patients in group 2 not treated by operation as well as penicillin developed a spreading decalcification of the bone, the area of which increased over one to five months. Workers at other centers have confirmed this.

In this series there was no death, no joint involvement and no secondary focus after admission. At the end of eighteen months, 4 patients still have a sinus, but 2 of these are nearly healed; 28 have normal function, 1 admitted with septic arthritis of the knee has limited range of movement and 1 has a sinus which keeps her in the hospital.

The importance of surgical drainage in these cases is discussed.

One case of infection with a penicillin-resistant organism was encountered early in this series. It is not included in the series, because at the time the authors had not sufficient penicillin for its adequate treatment. The organism was four times as resistant as the normal staphylococcus; it would have required at least 400,000 units of penicillin in twenty-four hours for bacteriostasis. The case serves as a reminder that the sensitivity of the organism must always be tested.

Report on the Use of Penicillin in the Treatment of Staphylococcal Infections With Special Reference to Acute and Chronic Osteomyelitis and Several Collateral Studies.—This project has demonstrated the

368. Agerholm, M., and Truetta, J.: Acute Hæmatogenous Osteomyelitis Treated with Penicillin, *Lancet* 1:877-881 (June 15) 1946.

manner in which penicillin is useful in the treatment of suppurative lesions in general and of osteomyelitis lesions in particular.³⁶⁹ It has also made possible radical modifications in the treatment of acute and chronic osteomyelitis to the end that morbidities are greatly diminished and convalescence greatly shortened. Though the authors' experiences and follow-up periods have been all too short to reach final conclusions, they nevertheless have been sufficiently clear to make some of the following conclusions reasonably certain and some others only tentative.

“(1) To be effective penicillin must be brought in intimate contact and in sufficient concentration with the offending micro-organism whether it be in the blood stream or in some localized focus. Localized foci when fully developed are usually not influenced by the systemic administration of the antibiotic, unless they are brought into close communication with the blood stream. The local application of penicillin is essential to the treatment of localized foci.

“(2) In acute hematogenous osteomyelitis, early local lesions which are not fully developed may be aborted, and small local lesions may be made to retrogress by the use of the systemic administration of penicillin. Large, fully developed foci are not influenced and though the surgical approach is made nonurgent, it is nevertheless necessary before the focus can be eradicated. The bacteremia is controlled and the metastasizing of the focus can probably be prevented by systemic therapy if the organism is susceptible.

“(3) In chronic osteomyelitis, the use of pre- and post-operative administration of intramuscular penicillin and the local application of the drug prior to the closure of the wound without drainage has made possible the healing of extensively saucerized areas by primary intention. The immediate results are spectacular and the follow up of these cases has been most encouraging.

“(4) In acute suppurative arthritis and bursitis the intramuscular and the intraarticular or intrabursal use of penicillin has in our limited number of cases completely resolved the lesions.

“(5) In acute suppurative soft tissue lesions healing by primary intention can in all probability be obtained, by incision and evacuation of the lesion, the local application of penicillin and primary closure of the wound in conjunction with the pre- and post-operative administration of penicillin systemically. In chronic lesions the fibrosed

369. Buchman, J., and Blair, J. E.: Report on Use of Penicillin in Treatment of Staphylococcal Infections with Special Reference to Acute and Chronic Osteomyelitis and Several Collateral Studies, *Bull. Hosp. Joint Dis.* 6:114-125 (Oct.) 1945.

abscess wall or sinus tract must be excised before healing by primary intention can be obtained.

"(6) The use of penicillin in acute postoperative bone and joint infections has been totally ineffective in their experience. Thorough drainage and complete removal of devitalized tissue and foreign bodies are essential before healing can be induced.

"(7) Tuberculous bone and joint lesions with secondary infections can be subjected to operative procedures and primary healing of the wound can be obtained by the thorough removal of the disease focus, the obliteration of the adjacent sinus tracts and the local application of penicillin prior to the closure of the wound without drainage in conjunction with the systemic administration of penicillin during the pre- and post-operative periods. A fair proportion of their limited number of cases have yielded good results. This method is worthy of further trial.

"(8) Healing by primary intention can be obtained in surgical procedures in close proximity to suppurative lesions by the application of penicillin to the operative site prior to the closure of the wound without drainage in conjunction with the pre- and post-operative intramuscular administration of penicillin. This approach has in their experience made possible several one stage amputations with the preservation of the adjacent joints which under other circumstances would have had to be sacrificed.

"(9) They have had very satisfactory experiences with the administration of intramuscular penicillin during the pre- and post-operative periods and the local application of the drug before closure of the wound without drainage in extensive surgical procedures on patients with inactive osteomyelitic lesions.

"(10) The postoperative systemic administration of penicillin has apparently prevented imminent post-operative infections in instances in which the operative site had been contaminated or unduly traumatized.

"(11) A large proportion (78.5% in this series) of cultures of coagulase reaction is unaffected. This *in vitro* resistance is temporary; strains of definitely high natural resistance may be encountered.

"(12) Staphylococci may be made resistant to penicillin by growth in progressively increasing concentrations in broth. Their metabolic activity is retarded and their pathogenicity is reduced or lost. The coagulase reaction is unaffected. This *in vitro* resistance is temporary; restoration to sensitivity, but only partial return to pathogenicity, may be effected by serial transfer in broth.

"(13) Staphylococci may acquire resistance during penicillin therapy. This occurred in 21.9% of the cases in this series. The metabolic

activity of resistant strains is retarded, but their pathogenicity is often unaltered. Such strains produce an inhibitor of penicillin. The coagulase reaction is unaffected. This resistance which is developed *in vivo* appears to be permanent.

“(14) Penicillin has no effect on the development of the coagulase reaction. It occurs even in the presence of concentrations of penicillin which are ultimately bactericidal. Penicillin has no effect on the formation of staphylococcal alpha-toxin, and neither enhances or destroys preformed toxin.

“(15) It is suggested that some significance must be attached to the development of resistance by staphylococci during penicillin therapy, because of the tendency toward permanence of the resistance developed, the continued pathogenicity of such resistant strains, and their production of a substance which inhibits penicillin.”

The Action of Penicillin on Staphylococci.—The resistance to penicillin which staphylococci may acquire during penicillin therapy tends to be permanent.³⁷⁰ As a rule it is accompanied with little loss of pathogenicity. This is in contrast to the loss of pathogenicity by cocci which are made resistant *in vitro*, a fact which has been cited as a reason for attributing little clinical significance to resistance. It is of particular significance that the coagulase reaction of staphylococci, which is a reliable indicator of their potential pathogenicity, is not lost when they become resistant to penicillin. This suggests that the capacity for pathogenicity persists even when the cocci become resistant. This masked or latent pathogenicity of strains which are made resistant *in vitro* is restored on their restoration to sensitivity. The pathogenicity of strains acquiring resistance during penicillin therapy often persists unaltered. Penicillin *per se* has no effect on staphylococcal toxin. Therefore the possibility must be kept in mind that staphylococci which become resistant to penicillin during treatment may maintain the infection or may initiate new infection. In addition, these penicillin-resistant strains have been shown to be resistant to the bactericidal action of whole blood and to produce a potent inhibitor of penicillin.

The development of resistance to penicillin has been considered by some not to be a major factor in the treatment of staphylococcal infections. However, several instances have been reported of the acquisition of resistance by staphylococci during penicillin therapy. In some of these it appeared probable that resistance to penicillin was a factor contributing to clinical failure or to an occasional relapse or recurrence after apparent cure. For the reasons given, the authors feel that some significance must be attached to the development of resistance by

370. Blair, J. E.; Carr, M., and Buchman, J.: The Action of Penicillin on Staphylococci, *J. Immunol.* **52**:281-292 (March) 1946.

staphylococci during penicillin therapy. The isolation of penicillin-resistant staphylococci from patients as long as a year after discontinuance of therapy emphasizes this point.

Since inadequate dosage of penicillin has been considered to contribute to the development of resistance, the necessity for early intensive administration of penicillin in staphylococcic infections is obvious. Even this does not guarantee that any given staphylococcus will not become resistant. Individual problems of dosage may occur in infections due to naturally resistant organisms. In order for penicillin to be effective it is essential that intimate contact with the bacteria should occur. In infections such as chronic osteomyelitis the ready access of effective amounts of penicillin may be prevented because of the relatively avascular nature of the lesion or of the dense fibrous tissue lining the sinus tracts. In these cases surgical intervention is necessary, both to remove as much infected tissue as possible and to allow access of penicillin to the infected area. Adequate surgical treatment in combination with penicillin therapy has been repeatedly stressed in the literature.

A large proportion of cultures of coagulase-positive *Staphylococcus aureus* are susceptible to penicillin. Some strains of definitely high natural resistance may be encountered. Staphylococci may be made resistant to penicillin by growth in progressively increasing concentrations in broth. Their metabolic activity is retarded, and their pathogenicity is reduced or lost. The coagulase reaction is unaffected. This in vitro resistance is temporary; restoration to sensitivity, but only partial return to pathogenicity, may be effected by serial transfer in broth. Staphylococci may acquire resistance during penicillin therapy. Their metabolic activity is retarded, but their pathogenicity is often unaltered. The coagulase reaction is unaffected. This resistance appears to be permanent.

Penicillin has no effect on the coagulase reaction. It occurs even in the presence of concentrations of penicillin which are ultimately bactericidal. Penicillin has no effect on the formation of staphylococcic alpha toxin and neither enhances nor destroys preformed toxin.

The implication of resistance acquired by staphylococci during penicillin therapy is discussed.

Topical Use of Concentrated Penicillin in Surface-Active Solution.—The available evidence suggests that topically applied penicillin containing 500 Oxford units per cubic centimeter may not be sufficiently concentrated for optimum therapeutic effect in refractory chronic infections.³⁷¹ Present pharmacologic purity and possible risk of establishing resistant strains of bacteria by selection justify an upward revision of concentration. Grace and Bryson found definite advantages in the use

371. Grace, E. J., and Bryson, V.: Topical Use of Concentrated Penicillin in Surface-Active Solution, *Arch. Surg.* 50:219-222 (April) 1945.

of 4,000 units per cubic centimeter in isotonic solution of sodium chloride with 0.1 per cent of the detergent sodium tetradecyl sulfate for local application to chronically infected areas of bone and soft tissue and for the treatment of infected areas of amputation. If experience in a larger number of cases confirms the efficacy of this simple procedure, it is possible that the magnitude of mutilating major surgical procedures for osteomyelitis may be substantially limited.

Nonoperative Treatment of Osteomyelitis with Penicillin.—Of 7 cases of chronic osteomyelitis involving the extremities, in 3 the hip was affected with either complete ankylosis or limitation of movement.³⁷² Individual treatment consisted of hospitalization for a period of from ten days to three weeks, with the use of a dosage of intramuscular penicillin (both the sodium and the calcium salt were used) varying from 10,000 to 20,000 units every three hours. In some cases from 20,000 to 50,000 units was used for the first four doses. Simultaneously from 4,000 to 20,000 units of penicillin per cubic centimeter was applied locally into the sinus tract with 1:1,000 "aerosol O. T." (dioctyl ester of sodium sulfosuccinate) or "tergitol 4" (sodium tetradecyl sulfate) in isotonic solution of sodium chloride. The local application of penicillin to the site of infection was made at regular three hour intervals with quantities of solution up to 4 cc. retained in each sinus cavity either by drainage or with a compression bandage. The drainage method was accomplished by placing the patient in such a position that the sinus, from its cutaneous opening, would be uppermost, thereby allowing the solution of penicillin and wetting agent to seep down by gravity to the area of infected bone. When this was not possible, petrolatum gauze dressings were placed over the sinus after the solution had been injected.

The authors had one definite failure and in a subsequent publication will present data emphasizing the importance of tracing the location of the sinus opening to the bone with contrast mediums and securing, with minimal surgical intervention, an opening in the sinus directly over this, enabling the optimum amount of solution to reach the infected bone. The simplicity of this principle is demonstrated in case 4, in which the draining sinus was 30 cm. from the infected bone. Prompt results were obtained as soon as the upper portion of this sinus, nearest the primary infection, received adequate penicillin.

Considered cosmetically, the nonoperative method of treating chronic osteomyelitis appears preferable to the older technic of saucerization or sequestrectomy, with its attendant mutilation and prolonged hos-

372. Grace, E. J., and Bryson, V.: *Nonoperative Treatment of Osteomyelitis with Penicillin*, J. A. M. A. 30:841-844 (March 30) 1946.

pitalization. In this series alone there had been a total of ninety-one previous operations without any clinical cure.

The removal of all sources of focal infection preparatory to treating patients with penicillin detergent is believed to be of vital importance.

Among war casualties, the high morbidity associated with osteomyelitis of the extremities may be substantially reduced if the effectiveness of nonoperative treatment is borne out by wider clinical experience.

The Management of Osteomyelitis Secondary to War Wounds.—Analysis of Results: An analysis of the results of wound treatment following saucerization by skin grafting, secondary closure and primary closure has been made.³⁷³ No case was considered successful unless the wound had been healed for at least three months. The results with the skin grafting type of treatment have been most satisfactory. A recent survey of 264 cases revealed complete healing of 25 per cent of the wounds in thirty days. At the end of sixty days another 50 per cent of the wounds had healed, leaving 25 per cent unhealed. Of the latter group, only 6 per cent were complete failures. The remaining patients needed partial resaucerization and skin graft. The failures of this method have been judged to be due to poor blood supply to the tissues under the graft, lack of maintenance of firm even pressure by the dressing after skin graft and lastly to infected tissues under the graft and incomplete saucerization. The skin graft method has been popular with the patients in military hospitals because it created a closed wound from a dirty infected one in a short period, eliminating the dressings, odors and inconveniences of some other methods. Since the soft tissue wounds healed quickly with this method, the bones likewise healed rapidly when they received a covering of skin. However, this treatment did not eliminate altogether the need for further surgical treatment in all the cases. Many deep and wide wounds having a thin skin covering needed good skin flaps with fatty subcutaneous tissues when further bone surgery was planned to keep them from breaking down with usage and for cosmetic reasons. The patients were usually given a trial of three months' hard usage on the extremities if the bones had healed. At the end of that period the patient did not need to undergo further surgical treatment if the skin wounds had not broken down, unless he wanted it for cosmetic reasons.

The results of delayed closure were encouraging, the wounds showing some drainage in 9 of 42 cases which were followed. A number of these wounds closed spontaneously after a few weeks' drainage. The secondary closures, in which a drain was inserted at the time of operation because of a dead space, usually closed spontaneously in the majority

373. Fischer, K. A.: *The Management of Osteomyelitis Secondary to War Wounds*, Surg., Gynec. & Obst. **83**:507-512 (Oct.) 1946.

of instances within seven to ten days after removal of the drain. The failures in this group of cases were attributed to incomplete surgical treatment and the leaving of a dead space where tissue fluids collected.

Primary closure was used in 46 patients, and wound drainage after surgery occurred in 10 instances. This low incidence of reinfection could probably be accounted for by the proper selection of cases for the use of an immediate closure.

Disseminated Coccidioidomycosis Localized in Bone.—Two cases of disseminated coccidioidomycosis with localized lesions in bone are presented.³⁷⁴ Both patients are Negroes and give a history of having been stationed in southern Arizona for eleven months.

Complement fixation studies of the patients' serum revealed *Coccidioides immitis*. Microscopic examination of biopsy material disclosed immature spherules in case 1 and typical, mature spherules in case 2. Cultures of material in both cases yielded colonies of *Coccidioides immitis*. Mice inoculated with these cultures died, and at autopsy gross lesions were found characteristic of a coccidioidal infection. Mice inoculated with concentrated curettings of the biopsy material died, and spherules characteristic of *Coccidioides immitis* were demonstrated in the gross lesions, and the organism was recovered from the animals on culture.

The patient in case 2 has since died as a result of disseminated lesions all over the body.

The Several Varieties of Actinomycosis.—In addition to the cervicofacial, abdominal and thoracic forms of actinomycosis, there are other important forms, such as mycetoma.³⁷⁵ Grains may be absent from lesions, and the actinomycetes may be aerobic as well as anaerobic. The actinomycetes are really higher bacteria.

The diagnosis of actinomycosis can be made by examination of pus or other material and by demonstrating either granules composed of branching filaments or branching filaments in the absence of granules. The anaerobic actinomycete will not be demonstrated by culture frequently since it is hard to grow and usually grown only from granules which have been isolated from pus. The aerobic actinomycete, however, may be cultured more readily, but it should preferably be seen on direct examination of pus or other material, in addition to being seen on culture, in order to know that the organism cultured came from the lesion and was not a contaminant.

374. Sashin, D.; Brown, G. N.; Laffer, N. C., and McDowell, H. C.: Disseminated Coccidioidomycosis Localized in Bone, *Am. J. M. Sc.* **212**:565-573 (Nov.) 1946.

375. Baker, R. D.: The Several Varieties of Actinomycosis, *J. M. A. Alabama* **16**:12-14 (July) 1946.

The granules of actinomycosis must be distinguished from the granules of maduromycosis, which have spores, and from the granules sometimes found in staphylococcic pus, which are composed of gram-positive cocci.

The treatment of the deep forms of actinomycosis, especially the abdominal form, has in the past been discouraging to say the least. But it has recently been shown that both the sulfonamide drugs and penicillin are of value. These, in combination with the use of iodides, thymol, surgery, rest and proper nutrition and roentgenologic study in some cases, offer more to patients with actinomycosis than has been available previously.

The Treatment of Chronic Osteomyelitis.—One hundred and forty cases of chronic infections of bone following trauma were studied.³⁷⁶ Sodium penicillin in the dosage of 40,000 to 50,000 units intramuscularly every three hours was of definite therapeutic benefit. The infections subsided, and the wounds healed, permitting surgical correction of the deformities within six weeks. This saved from five to twenty-four months, the usual recommended interval between the healing of osteomyelitis and any surgical reconstruction for the patient's defects.

Sodium penicillin in lesser doses failed to prevent recurrent attacks of osteomyelitis in these cases when the patients were subject to operative procedures within six weeks after the wounds had healed and the bone infection had subsided. Sulfadiazine also permitted a large percentage of recurrences of the infection after operation.

The penicillin in doses of 15,000 to 25,000 units not only failed to prevent recurrent attacks of osteomyelitis but seemed to be harmful in that the micro-organisms developed a tolerance for this drug. When doses of 40,000 to 50,000 units were later given to the patients, no effect whatever was noted on the virulence of the infection.

Besides the pathogenicity of the micro-organisms in the wounds, many other factors influenced the healing rate. Not the least of these was the state of nutrition of the patients. Most of the patients in this study were suffering from a variable degree of emaciation, secondary anemia and anorexia.

Whole eggs in milk were fed routinely to all patients twice daily between high caloric meals because of the required concentration of amino acids necessary for the reconstruction of the wounded tissues; growth factors must also be supplied to the parasitic bacteria by the patient through the infected bone and other tissues. This may include not only the amino acids, but purines, pyrimidines, oleic acid, vitamins and hemin.

376. Puckett, H. L.: The Treatment of Chronic Osteomyelitis, J. Internat. Coll. Surgeons 9:581-586 (Sept.-Oct.) 1946.

Penicillin in adequate doses (40,000 to 50,000 units every three hours) is the most valuable therapeutic agent yet introduced in the treatment of chronic osteomyelitis of traumatic origin. Wounds in 94 patients of 100 treated by this method ceased draining and healed after an average of sixty-six days. Twenty patients of this series were operated on for the correction of their deformities within six weeks after drainage had ceased from the osteomyelitis. Some of the surgical procedures were major operations and had to be repeated in stages before the deformities were corrected.

No recurrence of the bone infections was observed after an average of seventy-five days. Previous writers have recommended from six months to two years between the cessation of all signs of bone infection and surgical correction of deformities. By making such corrections within six weeks, not only is much time saved, but the morale of the patient is improved as well as that of other patients awaiting surgical reconstruction.

In Caldwell's³⁷⁷ first series of 41 cases, there were 16 cases of localized osteomyelitis following compound fracture. Ten tibias, three humeri, two small bones of the foot and one femur were involved. Since then perhaps half as many more have been cared for. The second group of hematogenous osteomyelitis material is more abundant. It contained 12 cases. Five femurs, four tibias, one humerus, one radius and one phalanx were involved.

In the first group of 16 cases, seven wounds were closed with the use of penicillin and six healed per primum. That does not mean that at the first dressing there was absolutely no pus about the stitches, but that within two weeks they were healed and dry. Two wounds were closed without the use of penicillin, both of which broke down. Secondary closures were accomplished in 5 cases; incomplete closure occurred in 1 patient, and 1 deserted.

In the second group of 12 cases nine wounds were closed with the use of penicillin, and they all healed; secondary closures were done on three, and they healed and did not reactivate over a period of a month.

The treatment of chronic osteomyelitis, particularly of the localized type, has been stepped up by surgical procedures that are designed primarily to excise as much of the scar and scarred bone as possible and then to accomplish closure with or without the assistance of skin grafting. Now all of that has been materially improved by the use of penicillin but as much or more so by the proper surgical approach. Caldwell states:

377. Caldwell, G. A.: Treatment of Chronic Osteomyelitis, *J. Omaha Mid-West Clin. Soc.* 7:92-95 (Aug.) 1946.

Likewise, we have been able to close many of the hematogenous type and get primary healing instead of doing, as we formerly did with chronic osteomyelitis, a sequestrectomy, a saucerization and packing with vaseline gauze, permitting it to heal over a long drawn out course and leaving a large scar that frequently broke down. With immediate closure we do not have the large scar, the remaining bone becomes much more healthy and we hope and pray is less likely to break down with abscesses, which give so much recurring trouble.

Cancellous Bone Grafts for Infected Bone Defects.—A Single Stage Procedure: In 52 infected bone defects cancellous chip grafts have been inserted after sequestrectomy and the wound closed, with success in 92 per cent.³⁷⁸

The method is applicable in traumatic osteomyelitis and in some cases in which the infection has been blood borne. No virulent infections have resulted, and there has been no flare-up of infection after healing for periods up to fourteen months.

In a small series in which traumatic osteomyelitis involved joints, chip grafts have been used after sequestrectomy, with healing and satisfactory fusion. Successful chip grafting in the presence of infection depends on (a) complete sequestrectomy and removal of all infected tissue; (b) an adequate vascular bed for the grafts which must have all cortex removed; (c) no dead spaces; (d) penicillin, systemically and locally, with sulfonamide therapy if indicated; (e) full thickness skin to close any skin defect, and (f) plaster immobilization (for soft tissue healing and until the bone is consolidated).

The one stage method for obliterating infected bone defects saves months of hospital treatment and restores function before disuse changes become irremediable.

The Use of Penicillin Therapy in Conjunction With Free Bone Grafting in Infected Areas.—Eight patients have been studied in whom free bone grafts have been implanted successfully in infected defects in bones in conjunction with penicillin treatment.³⁷⁹ Seven of these patients had infected fractures of large bones of the lower extremity with nonunion, and 1 had a contaminated defect resulting from an extensive resection of bone following removal of a secondarily infected tuberculous knee joint. The pathogenic bacteria cultured from the wounds of these patients were hemolytic *Staphylococcus aureus* in 4 cases, beta hemolytic streptococcus and hemolytic *Staph. aureus* in 2 cases, *Escherichia coli* and hemolytic *Staph. aureus* in 1 case

378. Coleman, H. M.; Bateman, J. E.; Dale, G. M., and Starr, D. E.: Cancellous Bone Grafts for Infected Bone Defects, *Surg., Gynec. & Obst.* **83**: 392-398 (Sept.) 1946.

379. Abbott, L. C.; Bost, F. C.; Schottstaedt, E. R.; Stern, W. E., and McCorkle, H. J.: The Use of Penicillin Therapy in Conjunction with Free Bone Grafting in Infected Areas, *Surg., Gynec. & Obst.* **83**:101-106 (July) 1946.

and *Streptococcus viridans* and hemolytic *Staphylococcus albus* in 1 case. Penicillin was given intramuscularly at three hour intervals before operations in 5 of the cases and after operations in all the cases. The dosage varied from 100,000 to 200,000 units per day. Prolonged treatment extending over many weeks was necessary. The total amount of penicillin used in each of these cases varied from 3,000,000 to 8,000,000 units.

The free bone grafting operations consisted of insertion of iliac grafts and metal plates (4 cases), sliding bone graft and metal plates (1 case), iliac grafts without metal fixation (2 cases) and sliding bone graft without metal plating (1 case). The operative wounds were closed completely in 7 cases, and in 1 case the wound was closed around a small soft rubber tube through which supplementary treatment with local penicilin was given. The most recent bone grafting operation had been done three months previously, and this wound had not yet been inspected, but there were no signs of infection and the patient left the hospital with plaster fixation. Immediate primary healing resulted in 4 cases; however, in 1 of these cases an adjacent sinus tract reopened after the operation and drained temporarily, and another patient returned for treatment of an infection that developed six months after operation. In 2 wounds necrosis and low grade infection resulting from tension developed at the site of closure, and these have required secondary closure and skin grafting procedures. One wound became infected and required drainage, but the patient was receiving inadequate doses of penicillin at the time.

At present the wounds of 6 of the 7 patients with grafting operations for infected nonunited fractures are healed completely, and 1 (which became infected six months after operation) is under treatment. On roentgen examination, the bone grafts in all these cases appear to be viable and in proper position, but 1 graft in a defect of the tibia fractured four months after operation and required a supplementary (fibular transplant) procedure. None of the grafts has sequestered, extruded or has been absorbed. Four patients have firm union of the fracture sites, with metal plates still in position, and 2 have firm union without metal plates. One patient has not yet had the original plaster dressing removed, and the remaining patient is the one for whom fibular transplant was required because the graft in the tibial defect fractured four months after the bone grafting operation.

Even though it has been possible under penicillin therapy to accomplish free bone grafting directly into the infected bone defects successfully in these cases, it is probably more desirable in most instances to attempt to obtain healing preliminary to the grafting procedure by penicillin therapy and, if necessary, by operations for removal of sinus tracts, infected granulations, scar and nonviable bone. The bone

grafting may then be accomplished at a later operation in a relatively cleaner field. Adequate dosage with penicillin is a useful adjunct in all cases in which bone grafting and other operations are done in areas in which there are bone defects infected with penicillin-susceptible organisms.

Skin Grafting in the Treatment of Osteomyelitic War Wounds.—During the past three years Kelly³⁸⁰ witnessed at close range the application of skin grafting technics to the healing and subsequent treatment of osteomyelitic wounds. There is little basic difference between closure by skin grafts, either free or pedicled, and secondary or primary closure as advocated by Key, Dickson and his associates, Churchill and Hampton during the war and the years which immediately preceded it. In some war wounds loss of both bone and soft tissue is so extensive that it precludes secondary closure, and some other means must be sought for inducing prompt healing. Free skin grafts will often effect healing of such wounds.

At Ashford General Hospital this work has been carried out in an orthopedic section manned by officers whose training has been in orthopedic surgery or general surgery or a combination of the two. A concerted effort has been made to satisfy the principles of skin transference, with especial reference to the avoidance of tension and the development and protection of the blood supply in pedicle grafts. In some instances the technic which could be applied to the task was inadequate to meet such basic requirements in the circumstances which arose. Obviously, these instances represent failures. These failures are in some measure offset by the prompt, good results obtained in the predominating group and by appreciation of the severe problems presented by some cases. Because of the tremendous number of battle casualties, the skill of the army plastic surgeon will not be available to many patients with osteomyelitis for several years. The orthopedic surgeon, with an understanding of the basic principles of skin transference but usually with little training in its details, will have to face some of these problems. It is the author's intent to present an abstract of the experience of the group with which he has been associated in this work.

The technic of plastic surgery can be applied to treatment of certain types of osteomyelitic wounds. Success in producing healing by free skin grafting has been considerable. Later stages of reconstruction in these instances have succeeded, often in proportion to the operator's facility in performing pedicle skin transplants. In replacing free skin grafts with pedicles in this group of patients, dead space presents a major problem. Contrary to the experience of others, attempts at Ashford

380. Kelly, R. P.: *Skin-Grafting in the Treatment of Osteomyelitic War Wounds*, J. Bone & Joint Surg. 28:681-691 (Oct.) 1946.

General Hospital to fill such cavities with iliac bone chips have resulted in a high proportion of infection; other filling materials have been used, with varied success.

Leonard T. Peterson called attention to the fact that the technic described by Colonel Kelly has been limited to observation of the orthopedic surgical procedures at a number of army hospitals. In the early months of the war it was customary to treat chronic osteomyelitis for long periods with plaster and infrequent dressings. Often the surgeon was reluctant to carry out the treatment required for adequate drainage and removal of sequestrums.

A more aggressive attitude has been taken with the excision of sequestrums and other devitalized tissue, followed by early skin grafting. Secondary closure of the wounds, without preliminary skin grafting, has not usually been successful. The development of early saucerization, followed by skin grafting, parallels closely the early secondary closure of compound wounds, as developed especially in the Mediterranean Theater and later practiced in all theaters.

The method represents one of the most important developments in reconstructive surgery of the war.

Repair of Bony Defects Associated with Osteomyelitis.—Chronic, localized hematogenous osteomyelitis continues to present a difficult surgical problem.³⁸¹ Infection is harder to control in bone than in other connective tissues. Bone is rigid, its vessels cannot contract or expand and its cavities do not collapse. Even if infection has finally been arrested, the surrounding bone is abnormal because of diminished circulation, increased density, loss of valuable organic material and isolated tiny cavities containing dormant organisms.

The advent of chemotherapy and the development of new procedures in the management of compound fractures during the war gave rise to the hope that osteomyelitis might be eliminated. As the end results of treatment become better known, it is evident that chemotherapy is not the entire answer to the problem and that well directed surgical measures must continue to be the mainstay for the treatment of chronic osteomyelitis.

A project, under the direction of the Subcommittee on Wounds and Burns of the National Research Council, was undertaken to evaluate various surgical procedures for the repair of bony defects associated with chronic osteomyelitis. The objects were to promote union of compound fractures with bony defects and infection and to obtain closure and healing of the infected bony cavities in chronic hematogenous osteomyelitis.

381. Caldwell, G. A.: Repair of Bony Defects Associated with Osteomyelitis, *Ann. Surg.* 123:698-701 (April) 1946.

Well directed surgical measures to remove dead bone, flatten cavities and obtain good soft part coverage of the remaining bone continue to be the mainstay for the treatment of chronic osteomyelitis. Penicillin and sulfonamide drugs play only a limited role in the elimination of infection and in final healing. Of 21 patients with localized osteomyelitis treated by various surgical procedures supplemented by chemotherapy, in 80.9 per cent the wounds healed per primum, but in only 61.8 per cent did they remain healed after five to twelve months. Of 22 cases of hematogenous osteomyelitis, again the wounds healed primarily in 81 per cent and, in 63 per cent they remained healed after five to twelve months.

Dr. William Darrach, in a discussion on Caldwell's³⁵¹ paper, said:

I should like to emphasize one point brought out that we as civilians have to face, and the men in the army and naval hospitals have to face; that is, the filling in of defects following gunshot or other wounds of the lower extremities, more especially the tibia. There is an underlying principle they have mentioned, which Champ Lyons brought out several years ago, and others have since—that is, the preparation of the patient prior to operative work in the final stage of treatment to fill in these defects. I think one of the most graphic descriptions of preparation of the patient comes from the Bible. . . .

If we are going to prepare any form of bone graft or filling-in of a cavity, we must pay attention to preparation of the patient from both a general and local standpoint. It is interesting to see how reparative bone processes will improve after a few transfusions; building up the patient from all points of view, general as well as local preparation, will determine very largely the success of our efforts.

DR. NORMAN T. KIRK: Wounded casualties in the Army amounted to approximately 571,000, of whom about 360,000 were returned to duty overseas. About 25,000 of our wounded died, approximately 4 per cent. I am told on good authority that the German losses in this category amounted to 8 per cent, and that during the winter campaign of 1944-45 about 13 per cent of their wounded died as a result of their injuries.

In my own mind there is no doubt why the percentage of American deaths from wounds was so much lower than the German percentage. I was in North Africa in April, 1943. I was in Italy the following year. What happened in the Medical Corps between those two dates is the explanation.

On the occasion of my first visit to the Mediterranean Theater of Operations, every medical officer in the Corps was treating patients, according to his own plans and policies. Some of the methods were very good. Others, to put it bluntly, were very poor. On the occasion of my second visit, every patient in the Theater was being treated according to the definite regimen instituted under the leadership of Colonel Churchill. Phases of military surgery and the missions of each echelon in respect to them had been clearly established. The first phase, initial surgery, was performed near the front lines. The second phase, reparative surgery, was performed in the Base Hospital behind the lines. The third phase, reconstructive surgery, was performed in the Zone of Interior.

It was this system of surgery, strictly adhered to, which gave the American Army the lowest percentage of deaths from wounds ever achieved in any Army. Before this method was developed, to give you a single illustration, the incidence of osteomyelitis following compound fractures was relatively quite high. Initial débridement was often imperfectly done, and delayed wound closure was infre-

quently practiced. Patients were put in plaster and arrived in this country with infected, malodorous wounds, the end-result of which was deformity.

Then the plan was changed. Initial surgery was thoroughly carried out in Field and Evacuation Hospitals. Primary closure was not permitted. It was impractical to secure precise reduction of fractures in the Forward areas, and the attempt was therefore not made. Instead, plaster designed primarily for transportation from the Forward Hospital was applied and the patient was transferred to the General Hospital in the Base. Once he reached the General Hospital, accurate reduction was achieved by manipulation or skeletal traction. The compounding wounds, if they were clinically clean, were closed by suture or skin graft, usually within five to ten days after wounding.

Patients were held in the Base Hospital until early callus formation would prevent displacement of their fractures during transportation. Those with fractures of the femur were held for eight to ten weeks, and sometimes longer, in skeletal traction. Then, in a lag-period, when no definitive surgical procedure was necessary, they were transported to the Zone of Interior.

Let me call your attention to several special points. In the first place, please note that it was the gross appearance of the wound which determined the time for delayed suture or skin graft, not bacteriologic studies. I yield to no one in my admiration for the bacteriologist in his place, but I thank God he was not available for use in this connection.

In the second place, while great advances have been made in reconstructive bone surgery, I do not myself classify a sliding bone graft of the tibia among them. I sometimes hear surgeons remarking that they can perform such grafts and "get away with them." Perhaps so, though not in most cases, and I do not believe, regardless of the outcome, that this method represents good surgery. Furthermore, we learned in the course of the war, and it is regrettable that we had to learn it over again at the patient's expense—we knew it 25 years ago—that any kind of graft is useless unless it is put into a properly prepared bed.

Finally, let me say a word about chemotherapy. We owe much to the studies of the National Research Council in this field, and the systemic administration, first of the sulfonamides and later of penicillin, undoubtedly saved many lives. . . .

All our badly wounded soldiers—between 260,000 and 280,000 of them—have been brought back to the General Hospitals in this country. The men with osteomyelitis, the men with bilateral amputations, the men who need multiple plastic operations and multiple hand surgery and other equally serious procedures have come home from the war. Their need now is primarily for specialized treatment. The fighting war is over, but the Medical Corps has still a job to do. That it will be finished with the same competence with which it was begun, I have not the slightest doubt.

DR. DUANE CARR: Over a number of years it has been my privilege to observe a reasonable number of patients with osteomyelitis of the bones of the thoracic cage. It is a problem on which Dr. John Alexander and I wrote some 10 or 12 years ago and at that time we advocated adequate surgical débridement of the tract followed by primary closure in those cases of tuberculous osteomyelitis uncomplicated with pyogenic infection. However, many of these cases of osteomyelitis of the sternum, ribs or clavicle were primarily tuberculous but complicated with pyogenic infection, following incision and drainage of the original abscess, resulting in a chronic mixed infection.

In our 46 cases a fairly large percentage of those treated with primary closure reopened. Many of our earlier mistakes, I believe, have now been overcome. Our practice now is the complete excision of all infected tissue and bone followed by primary closure with a pressure dressing, even in the mixed infected cases. Peni-

cillin before and after operation is a helpful adjunct, but we found our principal mistake formerly was in failing to carry out a more complete excision. Osteomyelitis of the thoracic cage complicated by tuberculosis has a tendency to develop sinuses boring through adjacent tissue and leading to other abscesses at some distance from the site of the original infection. Many of these sinuses are so small as to escape detection in the operative wound. I have, therefore, routinely used the injection of one per cent methylene blue under gentle pressure before the excision is begun and, to be complete, the excision must include all stained tissue. A spot less than one millimeter in diameter may be a sinus leading to an abscess elsewhere or even osteomyelitis of adjacent bony structures.

The use of methylene blue, the complete excision of all diseased tissues, primary closure without drainage, a pressure dressing, and penicillin before and after operation, have resulted in 100 per cent permanent closure in the limited number of patients so treated in the past two years.

DR. CHARLES S. VENABLE: I have enjoyed the very scholarly presentation of Doctor Caldwell and am for once not in any disagreement. I think, however, there are some few very salient factors that may be taken in their order in doing secondary rearrangement and rehabilitation following destructive osteomyelitis. General Kirk "rang the bell" when he said you cannot expect sulfa and penicillin to take all the cockroaches out of the kitchen. It takes plenty of good surgery, as we learned in the last war. Let us grant this has been done and we come to the defects following osteomyelitis. I think we must give the time-element a sufficient waiting period to know that no further necrosis is beginning in the bone ends. That gives an expression of the blood supply, because if this is insufficient, union will not take place. When this has been decided—the condition of the tissues and even spots of regeneration of bone—the remaining periosteum must be removed and the bone ends denuded entirely to assure the blood supply to both ends of the graft. This must be firmly fixed, because if there is movement, fibrosis will occur at one or the other end and union will not take place. I think soft-tissue closure is almost as important because, after all, blood supply is what it takes; closure of the soft-tissue so closely and completely about the graft that it may pick up blood supply between its ends. A dead space there is an exposure to defeat.

DR. ROBERT W. JOHNSON: My introduction to chronic osteomyelitis took place at the hands of Doctor Halsted. In those days we were sterilizing these cavities after radical excision and saucerization by pure carbolic acid, followed by alcohol, and lavage with at least ten gallons of bichloride solution. With his meticulous technic the field was cleaned and redraped, and we transferred to an entirely clean instrument table and set-up. Even after this heroic procedure the blood clot would break down and the wounds show the same organism as before. The experience sold me on the idea that the wound of an osteomyelitis could not be sterilized by any local method, and later experience with Dakin's solution, maggots, sulfa compounds, and penicillin locally have only served to confirm this. We have, however, an entirely new help in systemic chemotherapy, working on the "patient-side" rather than the "doctor-side" of the wound. This is the greatest advance that has been made, and this change in method and point of attack has been shown splendidly by the essayists.

I think that Doctor Caldwell's slides on the pathology, with which he introduced his remarks, are the crux of the situation. He shows that he is dealing with the pathologic tissue and not the cavity. The cavity is one thing, the pathologic tissue in the wall of the cavity is another, and this latter is what we must keep in primary consideration. We are dealing with tissue, ill-supplied with blood at best, which has little chance to become hyperemic, and with bone trabeculae and scar-filled

spaces it has little power of healing. This is why bone cavities differ from other scars in healing ability. New blood supply is simply unable to reach the site of the disease. While this is true in acute osteomyelitis, it is ten times more so in the chronic type. All the measures that have been suggested are of value—grafts of skin, flaps, muscle flaps, *etc.*, in that they reduce the area to be filled in and/or bring with them new vascular supply to aid in the process. Major Kelly's cases which we were privileged to see yesterday, are even more convincing than his excellent paper of today.

DR. FREDERIC W. BANCROFT: I would like to emphasize the difference in the healing of fractures of bone and ordinary connective tissue. Bone consists of two elements: a cellular element and a matrix which has low metabolic needs and can persist for a considerable time without the presence of cellular elements. When a bone transplant is imbedded, sections of this bone two or three weeks after operation will show the absence of osteoblasts in the bone spaces. As time goes on, if graft is to succeed, there will be revascularization through the vessels entering the Haversian canals and about these vessels will appear numerous bone cells in the canaliculi. If revascularization does not occur in the bone graft and cells do not reappear, the bone eventually atrophies, or if infection be present it is cast off as a sequestrum. I believe that we see the evidence of bone atrophy in late fractures of the graft when the transplant is not laid in a vascular bed.

These observations are important clinically because they show us that we must place a graft in an area free from scar tissue and infection if we expect the graft to persist and become living bone, which occurs by a gradual process of creeping replacement.

Chemotherapy in Surgery.—A brief review of the usefulness of chemotherapeutic agents (sulfonamide drugs, penicillin, streptomycin) in surgery is presented.³⁸²

Their principal uses are prophylactically to reduce the hazard of surgery in contaminated operative fields, primary therapeutic use with limited procedures and secondary therapeutic use as an adjunct to surgical treatment.

Systemically administered sulfonamide drugs and penicillin may be given to prevent invasive wound sepsis from streptococcic and staphylococcic infections in accidental wounds and burns and in operative wounds.

Orally administered succinylsulfathiazole, phthalylsulfathiazole and streptomycin may be useful adjuncts to surgery of the gastrointestinal tract.

Combined penicillin and streptomycin, administered systemically, by inhalation or by instillation, is suggested as a means of reducing infection in surgery of the lung. Streptomycin alone may prove a valuable adjunct to the surgical treatment of pulmonary tuberculosis.

For the treatment of invasive infections, penicillin in doses of 400,000 to 1,200,000 units daily is recommended. Patients with peritonitis should also be given streptomycin (1.5 to 2 Gm. daily). In

382. Lockwood, J. S.: *Chemotherapy in Surgery*, J. A. M. A. **135**:747-749 (Nov. 22) 1947.

infections involving a joint or the pleural cavity, pus should be aspirated and replaced with penicillin solution (5,000 to 20,000 U./cc.).

Infections which may respond to chemotherapy alone are listed as follows: cellulitis, lymphangitis, bacteremia; acute hematogenous osteomyelitis; suppurative arthritis; acute thoracopulmonary suppuration; spreading peritonitis; furuncles and carbuncles.

Infections which certainly require both chemotherapy and surgery are as follows: acute appendicitis with local peritonitis; chronic osteomyelitis; infections of the hand and foot, with or without diabetes; bronchiectasis, chronic empyema and pulmonary abscess; gas gangrene; chronic granulomas, including actinomycosis.

The usefulness of sulfonamide drugs, streptomycin and particularly penicillin in the treatment of surgical infections is discussed.^{382a}

Sulfonamide drugs have proved useful in acute infections caused by the hemolytic streptococcus, pneumococcus and gonococcus but have been of little or no value in those due to the hemolytic staphylococcus. The limitations of sulfonamide therapy include inactivity in pus, wound exudates and necrotic tissue, bacterial resistance and the development of drugfastness by bacteria, toxic reactions and drug idiosyncrasy.

Penicillin therapy is largely without these limitations.

Neither sulfonamide nor penicillin therapy will prevent the development of local infection in contaminated wounds, but both may inhibit or control any infection which develops, thus preventing invasive infection. Since penicillin is effective against staphylococci, which usually cause wound infections, it is superior to the sulfonamides.

Between November 1942 and February 1947, 754 surgical infections were treated with penicillin; 465 were established staphylococcic infections. It is concluded that "penicillin is the chemotherapeutic agent of choice in the treatment of all staphylococcal infections in surgery and that it has replaced all previous forms of chemotherapy."

In early diffuse infections, penicillin therapy frequently produced complete and spontaneous resolution. When treatment was begun later, frequently the infection was localized, obviating the necessity for radical operations.

The mortality in 40 cases of staphylococcic septicemia treated between 1940 and 1942 with sulfonamide drugs, surgery or bacteriophage was 67.7 per cent, while that in 51 cases between 1943 and 1946 in which penicillin was given was 30 per cent. Penicillin therapy "was most successful in young adults or children in whom the diagnosis of staphylococcal bacteremia was made early, penicillin therapy given early and intensively, and surgical drainage was possible when indicated."

382a. Altmeier, W. A.: Chemotherapy in Surgery, *J. Missouri M. A.* **44**: 803-809 (Nov.) 1947.

Penicillin is also "the chemotherapeutic agent of choice" in the treatment of carbuncles. Among 54 patients treated between 1944 and 1946 with 15,000 to 20,000 units intramuscularly every three hours for an average of seven days, there was complete spontaneous resolution in 27.7 per cent, partial resolution with necrosis in 22.2 per cent, abscess formation in 44.4 per cent and failure in 1.8 per cent.

"Penicillin is a powerful and effective chemotherapeutic agent in the management of acute osteomyelitis, and it has greatly modified both its management and roentgenographic interpretation." When adequate treatment was started within the first two or three days, surgical intervention was usually unnecessary and abscess formation was rare. When treatment was delayed for seven to ten days, there was extensive bone destruction, abscess formation and sequestration.

Among 59 cases of chronic osteomyelitis, spontaneous resolution occurred in only 9. Surgical treatment was required in the remainder.

Penicillin proved far superior to the sulfonamide compounds in the treatment of anaerobic streptococcic infections and was effective in sulfonamide-resistant hemolytic streptococcic infections.

In pneumococcic infections, penicillin was reserved for those that were sulfonamide resistant. Excellent or good results were obtained in 48 of 70 cases.

No beneficial effects were observed with penicillin in 22 cases of established generalized tetanus.

Penicillin proved "a valuable therapeutic agent" in 9 cases of human bite infections.

Excellent results were obtained with penicillin therapy in 3 of 4 cases of the streptobacillary type of rat bite fever.

"Penicillin is by far the chemotherapeutic agent of choice in the treatment of gas gangrene." Large doses of penicillin (1,000,000 units every three hours) together with adequate surgery are necessary for successful results.

Best results in actinomycosis are achieved by penicillin in full dosage for four to eight weeks together with sulfadiazine continued for four to six months.

Infections due to organisms susceptible to streptomycin therapy occur less frequently than those due to organisms susceptible to penicillin. Successful streptomycin therapy depends on the use of large doses from the beginning to prevent the development of organism resistance and early surgical drainage of abscesses before such resistance occurs.

Development of Bacterial Resistance to Antibiotics.—The development of resistance to the antibiotics is a phenomenon of great theoretic interest to the bacteriologist, and it may some day become a matter of

major concern to the clinician.³⁸³ Miller limits his discussion to penicillin and streptomycin, the two antibiotics which have been most intensively studied clinically and experimentally and about which, therefore, a good deal of information has accumulated.

Penicillin resistance when it does develop proceeds slowly. It has not as yet become a serious clinical problem because most infections are brought under control before any appreciable degree of resistance has had time to develop and also because most patients at the present time receive doses of penicillin sufficiently in excess of the minimum required to take care of any increase in resistance which might occur during the course of their treatment.

Streptomycin resistance, on the other hand, can develop with great rapidity. This has been observed clinically as well as experimentally. It is probably due to the production by bacteria of streptomycin-resistant variants which arise by mutation. Such variants have been described for several bacterial species. In the case of *Meningococcus*, two streptomycin-resistant variants have been observed, one of which is remarkable in that it requires streptomycin for its growth in vitro and in vivo.

Penicillin in the Treatment of Chronic Osteomyelitis.—The response to penicillin therapy in chronic bone infections was not dramatic.³⁸⁴ The initial injury followed by a low grade infection produces fibrosis and results in impaired local circulation. As the condition becomes more chronic, osteomyelitic cavities become sclerosed, preventing the penicillin from reaching the diseased area in adequate concentrations, and since sequestrums have no blood supply it is practically impossible to sterilize them.

In this study of 58 patients with chronic bone infections, some of which were treated with penicillin alone and some with penicillin and surgery, certain facts were found which the authors believe are worthy of note.

(1) Penicillin by inhibiting the growth and multiplication of bacteria will arrest infection in cases of chronic osteomyelitis with no sequestrums and in a high percentage of cases will allow healing to take place within a short time after the administration of the drug. In 64 per cent of the authors' cases the infected areas closed under specific therapy and with specific therapy and surgical treatment.

(2) Penicillin is of definite value in decreasing postoperative complications. There was none in their group of patients operated on.

(3) With adequate systemic penicillin therapy, the local administration of the drug is unnecessary and even undesirable.

383. Miller, C. P.: Development of Bacterial Resistance to Antibiotics, *J. A. M. A.* **135**:749-751 (Nov. 22) 1947.

384. Kaplan, I. W., and Bauer, G. H.: Penicillin in the Treatment of Chronic Osteomyelitis, *Texas State J. Med.* **42**:202-204 (July) 1946.

(4) Pyocyaneus was present in 16 of the 21 cases in which the patients did not respond favorably to penicillin therapy and may well be one of the important causes for failure.

(5) The presence of mechanical factors, such as fibrosis, sequestrums and sclerosis of bone, all influence the efficacy of penicillin. Because of the decreased vascularity of the diseased area and of the nontoxicity of the drug, it is recommended that comparatively large doses of penicillin be administered, 240,000 units daily, in an effort to increase the local concentration in the affected area.

(6) The use of penicillin will not obviate the need for surgical treatment. Sequestrums when present must be removed. In a small number of cases the infection might have healed without specific therapy during the five month period covered by this study. The authors are also aware of the fact that some of the wound closures do not represent cures and may later break down.

The treatment of chronic osteomyelitis is a problem not yet successfully solved.³⁸⁵ In modern surgery the problems have revolved around (a) the extent to which diseased bone should be removed; (b) the time at which to perform operation; (c) the method of filling in bone defects, and (d) the method of treatment before and after operations.

An investigation was undertaken at Christie St. Hospital, Toronto, Canada, in October 1943 to study the effects of penicillin in the treatment of chronic osteomyelitis resulting from compound fractures or blood-borne infection. Of the 57 patients in this series, who were initially treated between October 1943 and August 1944, 43 had septic compound fractures following battle wounds or accidents, while 14 had disease of hematogenous origin. Fifty cases have been followed to December 1945.

In the first six weeks of the investigation, penicillin therapy was used alone. As the results of this initial study were disappointing, surgical measures were also used in subsequent cases when indicated.

The effect of penicillin alone is described in cases of chronic osteomyelitis with sequestrums, cavities or other conditions for which surgical procedures are usually carried out. The results were poor.

The effect of penicillin alone is described in cases which did not require operation or in which operation was contraindicated. Of 5 such cases, complete healing occurred in 3 and great improvement in 2.

The effect of penicillin combined with surgical procedures is described. Of 52 patients, 43 are completely healed and 9 are unhealed. There were 24 patients who had recurrences after the first operation.

Results are given in 50 cases followed for fifteen to twenty-five months.

385. Hebb, H. D.: The Role of Penicillin in the Treatment of Chronic Osteomyelitis, *Canad. M. A. J.* 54:446-450 (May) 1946.

It is recommended that penicillin be used in the treatment of chronic osteomyelitis. In most cases, its use should be combined with adequate surgical treatment both before and after operations.

It is recognized that final assessment of treatment cannot be made for many years because of the nature of the disease.

The Treatment of Chronic Osteomyelitis by the Use of Muscle Transplant or Iliac Graft.—Prigge³⁸⁶ presents the method used in treating sixty-four separate foci of chronic osteomyelitis in 61 patients during a period of sixteen months. Practically all areas of the skeleton were affected. In 4 cases major joints were involved with suppurative arthritis. Healing occurred in a high percentage of cases within ten weeks, and there have been no recurrences, pathologic fractures or fatalities. The average period of observation was seven and one-half months. All patients were males between 18 and 37 years of age. The disease was due to the usual causes, being hematogenous in 4, secondary to operative infection in 6 and secondary to infected compound fractures in the remainder. The chronic granulomas of bone are not included in this series, although this method should be applicable in selected cases of this type of chronic bone infection.

The management of chronic pyogenic osteomyelitis is one of the most distressing problems in the field of orthopedic surgery. Whether it is secondary to infected compound fractures or to operative infection or whether it is hematogenous in origin, the bone infection has been difficult to eradicate. Too often it results in crippling from stiffened joints, atrophied muscles, recurrence of the disease, pathologic fractures and occasionally delayed union or nonunion of infected fractures. The chronic sepsis enforces an interminable delay in undertaking reconstructive surgery. Frequently, it is the direct cause of secondary anemia and the rare, but serious, complication of amyloid degeneration. Nephrolithiasis is not an uncommon finding in debilitated patients, particularly when prolonged recumbency is necessarily enforced. If there is a lesion of a peripheral nerve, associated with a compound fracture—as is frequently seen, due to the perforating, high speed missiles of modern warfare—it is imperative to clear up infection early, in order that definitive neurosurgical procedures may be accomplished without delay. The longer the time interval between laceration of nerve tissue and surgical repair, the poorer is the prognosis for recovery of the paralyzed muscle groups.

The advent of the bacteriostatic drugs, particularly penicillin, at first gave promise of a possible cure. However, it soon became apparent

386. Prigge, E. K.: The Treatment of Chronic Osteomyelitis by the Use of Muscle Transplant or Iliac Graft, *J. Bone & Joint Surg.* **28**:576-593 (July) 1946.

that penicillin, like the sulfonamide drugs, would not be effective, either systemically or locally, in tissues with little or no vascularity. Such tissues include sinus tracts with the surrounding cuff of dense scar tissue, bone abscesses containing chronically infected granulation tissue, sequestrums and areas of eburnated bone which are frequently found at sites of chronic osteomyelitis. Furthermore, the newer bacteriostatic drugs, such as streptomycin, could hardly be expected to accomplish better results after chronic bone infection has become established. The value of these drugs as adjuvants to the surgical treatment of osteomyelitis is considerable, however, since more radical surgical procedures are possible without danger of the localized infection becoming disseminated or assuming an invasive character. In all the cases reported here, penicillin only was used, as it is less toxic than the sulfonamide drugs. Streptomycin was not available.

The prompt and permanent healing of chronic pyogenic osteomyelitis is imperative, in order to prevent the many serious complications and sequelae and to permit early reconstructive surgical intervention when necessary. With the present day bacteriostatic drugs, more radical procedures can be accomplished without danger to life or limb.

Sixty-four separate foci of chronic osteomyelitis in 61 male patients between 18 and 37 years of age have been treated during the past sixteen months. Early healing (within ten weeks) occurred in 78.1 per cent. Including the 8 cases in the iliac graft series, in which healing was delayed over the ten week period, and the case in which reexcision was necessitated by a secondary sequestration, complete healing occurred in 93.7 per cent.

The method used and advocated is founded on the principle of complete excision of an infected and avascular tissue, obliteration of the "dead" space and wound closure. Whenever possible, obliterating the dead space with viable muscle has been the method of choice, since 97.7 per cent of the wounds in this group healed promptly. Bone grafting should be done later, if necessary, to reenforce any bone weakness. In the calcaneus, the anterior surface of the tibia and the radial styloid, obliteration of the dead space with grafts of cancellous iliac bone has shown definite merit and has been time saving.

Bone Felon.—Drawings were presented by Lovejoy³⁸⁷ to show the severe disabilities from a relatively simple condition in 4 cases and to suggest a means of avoiding this disability.

A plea is made for the early diagnosis of this condition and for lateral drainage. This will prevent a painful, disabling scar on the digital pad. A double lateral incision with through and through drain-

387. Lovejoy, J. F.: Bone Felon, U. S. Nav. M. Bull. 46:1465-1466 (Sept.) 1946

age is often indicated and easily accomplished. The optimum time for drainage can be readily determined by careful daily observation. Even though there is a tendency for the abscess to point through the digital pad, this can be averted by a lateral incision. Chemotherapy is indicated preoperatively and postoperatively. The local use of penicillin has been found advantageous in the experience of the writer.

Penicillin and Bone Grafting Operations.—Among 3,000 war fractures it was deemed advisable to perform bone graft operations, in order to facilitate union, in only 93, or 3 per cent.³⁸⁸ Fifty of these operations were performed before penicillin was available for their use. Forty-three operations have been performed utilizing penicillin.

The purpose of Branch and Moldavsky's article is to offer an analysis of these 93 bone graft operations on war fractures so that a comparison will be available of the end results of those operations done without penicillin and those in which penicillin was utilized.

Of 3,000 war fractures treated, it was necessary to use bone graft in only 93, or 3 per cent, to obtain union. Of these 93 bone graft operations, there were 50 done without utilizing penicillin and 43 in which penicillin was utilized.

Statistics, case reports and discussions of these 93 bone grafted fractures have been given so that a comparison may be drawn between operations performed without penicillin and operations in which penicillin was utilized. There has been a special effort to make readily available the statistics on postoperative wound healing in cases in which operation was performed without penicillin and in those in which penicillin was utilized.

Infection in the 8 postoperative cases remained localized, but bone grafts were lost in 2 cases when penicillin was not given and in only 1 case when penicillin was administered.

In this series the infection was less disturbing and the wound healing results were best in cases in which administration of penicillin was started two days before operation.

The Treatment of Extensive Actinomycosis.—Interest in the problem of the treatment of extensive actinomycosis was aroused by a case of advanced abdominal actinomycosis occurring in a young girl.³⁸⁹ Over a period of several months, the progress of the disease was arrested and the patient rehabilitated to a normal life and probably cured. A review of the hospital records revealed that although the results from the treatment of mild or early actinomycosis by a variety of

388. Branch, H. E., and Moldavsky, L. F.: *Penicillin and Bone Grafting Operations: Evaluation of Operations Performed Without Penicillin and Those Performed with Penicillin*, *Mil. Surgeon* 99:25-31 (July) 1946.

389. Kolouch, F., and Peltier, L. F.: *Recent Advances in Surgery: Actinomycosis*, *Surgery* 20:401-430 (Sept.) 1946.

therapeutic agents were good the treatment of advanced actinomycosis was uniformly unsuccessful. With this in mind, the case records have been carefully examined and compared, and a review of the literature has been made. The collected information has been used as a basis for an evaluation of the treatment of extensive actinomycosis.

The results in the treatment of cervicofacial actinomycosis show a close correlation between the extent of the lesion at the time treatment was instituted and the eventual prognosis. The results in the treatment of thoracic and abdominal actinomycosis have been poor. The success with the last case, however, indicates that the prognosis for any of these patients should not be hopeless.

Success in the treatment of actinomycosis depends to a large extent on early diagnosis of the condition since circumscribed lesions will respond satisfactorily to any of the recognized forms of treatment. Extensive involvement, irrespective of location, presents a serious

*Results of Treatment of Cervicofacial Actinomycosis in 16 Cases
Classified as to Type*

Type	Number	Cured	Healing	Dead
1	7	5	2	0
2	6	5	..	1
3	3	..	..	3

threat to the life of the patient and a challenge to the ingenuity and perseverance of the physician.

Cervicofacial actinomycosis has proved relatively amenable to irradiation, surgery or chemotherapy. The mortality of this type of infection results from extensions of the infection into vital structures. Repeated excision and curettage as emphasized by Wangenstein appears to be the treatment of choice in extending infections. Adjuvant chemotherapy enhances the possibility of success in the extensive lesions treated by surgical measures.

Thoracic actinomycosis has been notoriously resistant to treatment prior to the advent of modern chemotherapeutic agents. The sulfonamide drugs and penicillin should bear the burden of treatment in these cases. Surgical procedures should be limited to the drainage of collections of pus and the excision of grossly infected tissue.

Results in the treatment of abdominal actinomycosis have been generally poor. Irradiation therapy of these lesions has been limited by the technical difficulties encountered in applying the treatment to the ramifications of the infected tissue. Aggressive surgical treatment of abdominal actinomycosis has been limited by the poor general condition of the patients. The role of supportive treatment (that is, high caloric intake, liberal transfusions) and of adjuvant chemotherapy is to restore and maintain the general condition of the patient at a

level tolerating repeated radical excision and curettage of the lesion. Favorable progress of the local lesion depends on meticulous wound hygiene, with the inhibition of secondary infection.

With the conscientious application of generous supportive treatment combined with radical surgical procedures the prognosis in extensive actinomycosis should continue to improve.

The Use of Absorbable Substances to Obliterate Bone Cavities and as Hemostatic Agents in Operative Procedures on Bones and Joints.—The use of oxidized gauze or absorbable gelatin with thrombin for hemostasis in the presence of troublesome oozing and bleeding has proved effective in difficult circumstances. The use of oxidized gauze is simpler than the use of absorbable gelatin and thrombin. The effectiveness of gelfoam has been found to be increased by investigators who have used suction to make it adhere to the bleeding area. The authors' ³⁹⁰ experience is limited to the simple application of the substance to the bleeding surface by pressure of the gloved finger or of an overlying piece of gauze, which is subsequently removed.

It is also apparent from the authors' limited experience that the use of these substances complicates the healing of the surgical wounds in an appreciable number of instances. These complications consist in the spontaneous evacuation of accumulations of blood and serum, with resultant temporary partial disruption of the wound. In at least one instance, ultimate failure of healing occurred as a result of secondary infection of such a temporarily disrupted wound. One should, therefore, weigh these possibilities carefully before resorting to the use of these hemostatic agents which in difficult circumstances are nevertheless of inestimable value in the control of oozing and bleeding.

The use of oxidized gauze or of absorbable gelatin as a vehicle for thrombin and penicillin in filling dead spaces or bone cavities appears to be inadvisable, from the authors' limited experience, because of the large proportion of complications interfering with the healing of the surgical wounds by first intention.

The use of oxidized gauze or of absorbable gelatin with thrombin as hemostatic agents in the presence of troublesome oozing and bleeding is advisable and at times invaluable, notwithstanding the fact that the final healing of the wound may, in a considerable proportion of instances, be delayed by temporary partial disruption incidental to the evacuation of collections of blood and serum.

Scheme of Treatment of Acute Hematogenous Osteomyelitis with Penicillin.—The following scheme of treatment has been drawn up at the Wingfield-Morris Orthopaedic Hospital as quoted from Trueta.

390. Buchman, J., and Blair, J. E.: The Use of Absorbable Substances to Obliterate Bone Cavities and as Hemostatic Agents in Operative Procedures on Bones and Joints, *J. Bone & Joint Surg.* **29**:650-658 (July) 1947.

Since June 1944, fifty cases of acute hematogenous osteomyelitis have been treated with penicillin at the Wingfield-Morris Orthopaedic Hospital, and there is now enough material to justify us in drawing up a routine plan of treatment which we are confident will, if followed in all its details, produce good results.

The following are the results to date:

- No death
- No amputation
- No deformity
- No joint infection after admission
- No secondary focus after admission
- No recurrence
- No pathologic fracture or dislocation

Forty-nine of the 50 patients have full function. One patient, the second to be treated, has limitation of knee flexion (0—90 degrees). The abscess was not drained.

Forty-seven of the 50 patients (55 foci) have sound healing. Two patients, both with early, undrained femurs, have each a small sinus, and 1 adult has a small sinus from the ulna.

Sequestra have been obtained from 7 out of 55 infected bones.

(a) Three patients discharged a small sequestrum through the scar at home, without inflammation and with prompt rehealing (os calcis, metatarsal, fibula).

(b) In 1 case involving the humerus sequestrectomies have been performed; at the initial operation the upper third only was drilled: the early radiograph showed that the whole shaft had been involved.

(c) In 3 cases involving the femur sequestrectomies have been performed; the wounds had not been drained in spite of the presence of pus. (21 femurs were treated, of these 5 were improperly treated without surgical treatment.)

We think these results good enough to justify us in asking surgeons to adopt the method and principles described below for two reasons:

1. We are convinced that the method is an excellent one.

2. We should like to collect a series of 100 patients, with 100 per cent survival and function, treated in the Wingfield-Morris Hospital, by a method which, provided care is used, is simple enough to be carried out in all hospitals.

It is hoped, therefore, that treatment will be followed exactly, and sufficient records kept and investigations done, for an exact account to be given by whomever eventually writes up the series. The follow-up for several years at six or twelve monthly periods is especially valuable, and no patient should ever be discharged!

Principles of the Treatment

1. Acute hematogenous osteomyelitis is in part a systemic disease; therefore penicillin must be given systemically.

2. Systemic penicillin can resolve inflammation which has not advanced to pus formation: therefore surgical interference is not necessary in a case coming to treatment without evidence of pus formation (i. e., with only a small area of tenderness).

3. Systemic penicillin cannot sterilize preformed pus: therefore pus present before treatment must be removed surgically.

4. Systemic penicillin prevents the formation of fresh pus after removal of that already present at the onset of treatment: therefore complete primary suture is safe and is especially recommended because of the susceptibility of penicillin wounds to gram-negative infections.

5. The damage to the bone circulation in acute hematogenous osteomyelitis is due not only to the infection but to the increased tension within the bone impairing the blood supply; this tension is not relieved when the subperiosteal pus is evacuated. The bone should, therefore, be drilled in several places to allow the release of tension. Extensive bone work is not necessary.

6. The success and safety of this treatment depends on two important factors:

(a) The organism must be sensitive to penicillin. The initial dose used here allows for a staphylococcus of four times the normal sensitivity, but every effort must be made in every case to obtain a report of the organism and its sensitivity.

(b) The patient must get his penicillin. If a drip does not run for any reason the interval must be filled by regular intermittent injections. There is no excuse for a patient not getting his penicillin.

7. General medical measures, e. g., hydration of the patient, blood transfusion if necessary, immobilization of the part, and vitamin and iron therapy, are as necessary now as ever. Perhaps the most important measure is adequate hydration by mouth, by means of the penicillin drip, and if necessary intravenously. Most of these patients are dehydrated on admission.

Standard Courses of Penicillin Treatment in Acute Osteomyelitis

The doses are regardless of age and size and preferably given by intramuscular drip.

1. Days 1, 2 and 3.....400,000 units daily for the first three days, or, in a doubtful case, until sensitivity of the organism is known
 Day 4.....300,000 units
 Days 5 to 10+.....200,000 units daily, for a minimum of ten days, or until the sutures are removed, whichever is the longer.
2.400,000 units to cover any 24 hour operative period.

If intermittent injection is used, 100,000 units must be given every three hours to obtain a constant bacteriostatic level in the blood.

Practical Application of the Treatment

1. Patients in whom there is no clinical evidence of pus are treated with penicillin and with general medical measures. The area is immobilized in such a way that the local condition can be carefully watched. These patients usually have quick relief from pain and, compared with patients operated on, a rather slow fall in temperature.

2. Patients in whom there is probably pus present are treated with penicillin for twelve hours, and during that time immobilization of the part and general medical measures, notably hydration, are instituted. Patients must not go to the operating theater in a dehydrated condition.

3. Operation. This aims at: (1) removing as much pus as possible, (2) allowing the periosteum to renew its contact with the bone, (3) releasing the tension within the bone and (4) avoiding secondary infection by primary suture.

(a) A tourniquet is used wherever possible to ensure a dry field.

(b) The joint is aspirated, if there is fluid present, before operating.

(c) The incision is centered on the point of maximum tenderness; it is long enough for good exposure of the bone.

- (d) As much pus as possible is removed from the tissue spaces surrounding the bone.
- (e) The bone is drilled in at least two places. When pus is found, further drill holes are made up and down the bone until the limit of the pus is found or until the epiphysis or joint capsule is approached.
- (f) The wound is sutured with interrupted sutures, without any form of drainage. Deep sutures are not used, but if a particular anatomic structure demands their use, surgical gut and not silk should be used.
- (g) The part is elevated and immobilized in such a way that the wound can be easily inspected and gently palpated. Complete plasters or plasters with windows are always a nuisance, for it is good to look at both sides of the limb; the related joint should never be hidden.

We have found the following immobilizations the most satisfactory.

1. Lower half of femur, leg and foot—plaster back slab. Lower half of humerus, arm and hand—plaster back slab.
2. Upper half of femur and pelvis—hip frame.
3. Upper half of humerus—(a) arm in sling and bandaged to side for first three days, (b) thoracobrachial cast applied on the third or fourth day; the arm part is bivalved and only the lower half, supported if necessary by a strut, kept.
4. Postoperative and convalescent. Patients operated on are usually inspected about the fifth day for hematoma formation or minor infection of the sutures. The sutures are removed on the tenth day. The penicillin should be continued until the stitches are out. In all cases the bone is immobilized until the general and local conditions are beyond suspicion and until the bone is strong enough to avoid any risk of fracture. Solid sclerotic bone does not develop in these cases. The patient is discharged to his home for a month in plaster to allow for the increased activity.

The following details are important in the subsequent analysis of cases, and we should be grateful if they could be recorded in all cases.

1. History

- Duration of symptoms, local and general
- Stage at which general practitioner called, his diagnosis and treatment
- Causes of delay in patient coming to treatment
- Past history, trauma, recent infection, e.g., boils and chronic ear discharge

2. Clinical Examination

- General condition
 - T. P. R., toxicity
 - Please record previous temperatures if known
 - Throat, ears, chest and renal tenderness
 - Palpation of entire skeleton for other foci
- Local condition

Position of limbs, swelling, redness, tenderness, exact location of point of exquisite tenderness, which are diagnostic of the disease, fluctuation

Condition of related joints, lymphatic involvement

3. *Special Investigations*

X-ray of lesion and of chest.

Blood examinations: Complete count

Culture (taken before treatment begun)

E.S.R.

Blood group

Penicillin concentration if already treated

Urine routine ward and to laboratory for deposit.

Swab from any discharging lesions or suspect throat for culture and sensitivity.

4. *Provisional Diagnosis and Plan of Treatment*

5. *Operation Note in Detail*

6. *Postoperative Course. Penicillin Details*

7. *Duration of Healing. Duration of Hospitalization and Immobilization*

8. *Final Statement of General Condition, Healing Joint Condition, Lengthening or Shortening of the Affected Bone or Limb*

Note on Pathologic and Bacteriologic Specimens

Specimens for bacteriologic examination must be accompanied by a form on which it is stated clearly whether a sulfonamide or penicillin is being used so that the action of these substances can be inhibited.

The sensitivity of the organism to penicillin will not be tested unless it is asked for.

Blood culture syringes are specially sterilized and kept in the drawer in the Pathological Laboratory under the microscope. Please sterilize the skin carefully before taking a specimen.

Nonoperative Treatment of Acute Hematogenous Osteomyelitis: Preliminary Report.—That “acute hematogenous osteomyelitis is best treated with penicillin and that surgical intervention is rarely indicated” is concluded from results in a series of 14 cases.³⁹¹ Three case reports are presented in detail.

In all cases diagnosis was based on the history and the physical and laboratory examinations and was later confirmed by roentgenologic findings. Duration of symptoms ranged from one to thirty-five days, with an average of 7.9 days.

Penicillin was administered intramuscularly in all cases in doses of 10,000 to 25,000 units every three hours. Total dosage ranged from 960,000 to 6,040,000 units. In 6 cases sulfadiazine was given in addition for two to six days. The authors state that no increased benefit was observed in these cases.

391. Killeffer, J. J., and Robertson, R. C.: *Non-Operative Treatment of Acute Hematogenous Osteomyelitis: Preliminary Report*, J. Tennessee M. A. 40:319-325 (Oct.) 1947.

The temperature became normal in two to eleven days, average 4.1 days, after the use of penicillin was begun. Treatment was continued for two weeks to two months after the temperature became normal.

There were no deaths in the series. Surgical treatment was required only once—incision of an abscess which had formed prior to admission. In 3 cases there was roentgenographic evidence of sequestrums which appeared to be revascularized. In 3 cases there was pathologic fracture resulting from inadequate fixation.

Infections of the Hands.—The value of penicillin in pulp space infection was studied in 100 consecutive cases in the outpatient hand clinic of a general hospital.³⁹² Personnel and methods of treatment were standardized. Cases included 69 of early simple felon, 20 of suspected bony felon and 11 of established bony felon.

Of the 100 cases of all types of felon, a pure culture of *Staphylococcus aureus*, penicillin sensitive, was grown in 99. In the remaining case, in which the finger was previously incised, *Streptococcus hemolyticus* was grown in the culture.

Principles of surgical treatment for simple felons and suspected bony felons included the lateral "hockey-stick" incision, division of the longitudinal septums and drainage of soft parts. Soaks, moist dressings and antiseptic baths were avoided. Instead, paraffin gauze dressings were used over a light film of penicillin powder.

Alternate patients among the 69 with simple felons were treated in addition with two intramuscular injections of penicillin, 100,000 units each, daily, for three days. No significant difference in morbidity time or in complications was observed in these patients.

In the 20 cases of suspected bony felon intramuscular injection of 100,000 units of penicillin twice daily for ten to twenty-one days proved adequate. Destructive osteitis was eliminated and the bone usually recalcified in a few weeks, without demonstrable sequestrums.

In 3 cases of established bony felon treated prior to this series by removal of the pulp and necrotic bone, results were disastrous. In the present series the surgical treatment was the same as that described for other types of felon. Penicillin, 100,000 units twice daily, was administered intramuscularly for at least two weeks. Every finger treated in this manner healed in eight weeks.

Penicillin in the Treatment of Acute Osteomyelitis.—There is yet to appear on the scientific horizon of therapeutic discovery an antibiotic that will match penicillin in its bacteriostatic power, its low tissue cell toxicity and the dramatic clinical response to it of patients infected with

392. Bolton, H.; Catchpole, B. N., and Japson, R. P.: Penicillin in Pulp-Space Infections of the Finger, *Lancet* 2:608-610 (Oct. 25) 1947.

susceptible micro-organisms.³⁹³ One has only to recall the ravages to the human body and the high death rate from sepsis wrought by the ubiquitous *Staphylococcus aureus* to appreciate the value of this marvelous drug.

It would appear that the hand of Providence has had a part in the discovery and development of penicillin, especially when one correlates its advent with the outbreak of the present global war.

Unfortunately, in treating osteomyelitis with penicillin, one may find an occasional infection with a penicillin-resistant staphylococcus.

It should be remembered that in a patient with a pocket of pus infected with a susceptible pathogen, even though the action of penicillin is not inhibited by organic matter such as pus (as are the sulfonamide drugs), it may not, for physical reasons, arrest the growth of staphylococci in the abscess and thus clinical symptoms may persist. It is recommended that drainage of such accumulations of pus be made, especially if clinical response be not immediately forthcoming. Again it is suggested that in cases not responding to penicillin one of the sulfonamides be prescribed and vice versa. There may also arise the occasional case in which both drugs may be used simultaneously to greater advantage.

It is reasonable to presume that the earlier therapy is instituted after the onset of symptoms in acute osteomyelitis the quicker will be the clinical response and the better the end result. Important, also, in this connection is the strong probability that the total required amount of penicillin necessary for complete sterilization of the focus will be much less.

Experience in treating a large series of cases, plus blood titration tests to establish minimal blood concentration of penicillin that will completely inhibit the growth of the offending micro-organism, will perhaps help to establish the necessary total dosage for each patient. Other pertinent factors to be considered, some being hard to evaluate in determining the total curative dosage of penicillin in each individual case, are the age of the patient, his resistance and the virulence of the micro-organism.

It was the opinion of Hamilton and Boyd at the time of writing that a safe method of procedure is to continue the use of penicillin for approximately five days after the temperature has returned to normal and that the total amount of penicillin used should be at least 1,000,000 units for patients with acute osteomyelitis.

The early and precipitous decline by lysis of the fever, along with obvious improvement in the well-being of the patient, is a favorable omen.

393. Hamilton, J. F., and Boyd, H. B.: Penicillin in the Treatment of Acute Osteomyelitis, with Case Reports, *South. M. J.* **39**:597-608 (Aug.) 1946.

The economic factor in reducing the length of hospital residence as a result of penicillin therapy is astounding when compared with the use of any and all former methods of treating acute osteomyelitis.

Although the authors are aware that the number of patients they have treated is too small for factual conclusions, they prophesy that now since the supply of penicillin has become unlimited and the medical profession at large has become cognizant of its value and methods of application, "chronic osteomyelitis" will be almost a thing of the past.

They conclude that (1) penicillin is a marvelous and powerful antibacterial agent, (2) its discovery by Alexander Fleming was more or less an accident, (3) it acts as both a bacteriostatic and a bactericidal agent under certain conditions, (4) its high antibacterial power is coupled with low tissue cell toxicity and (5) it is reasonable to presume that since penicillin has become unlimited and the general medical profession is aware of its value "chronic osteomyelitis" will become almost a disease of the past.

Treatment of acute hematogenous osteomyelitis with penicillin prevents formation or causes dissolution of metastatic foci and disappearance of the primary osseous lesion within three to four weeks in approximately 90 per cent of the cases.³⁹⁴ To obtain such results the treatment must be instituted early, the dose must be adequate, the medication must be continued for a sufficiently long period and the periosteal and metastatic abscesses must be drained.

The following steps are recommended by the author: (1) immobilization of the affected extremity in a splint for thirty to fifty days; (2) general treatment consisting of daily intravenous administrations of 1,000 to 2,000 cc. of dextrose or sodium chloride solution to combat dehydration, toxemia and acidosis, daily transfusions of 200 to 500 cc. of blood to fight bacteremia and secondary anemia, high carbohydrate diet and administration of vitamins; (3) administration of 15,000 units of penicillin intramuscularly every three hours, the total dose ranging from 1,000,000 to 5,880,000 units, according to the patient's resistance, the virulence of the micro-organisms and the time the treatment was initiated. The administration of penicillin is stopped two weeks after the return of the temperature and the leukocyte count to normal levels. Abscesses in soft parts are aspirated every third day, and 5,000 units of penicillin are injected. Administration of penicillin is supplemented by 20 to 30 Gm. of a sulfonamide compound.

394. Pires de Camargo, F., and Toledo de Carvalho, E.: A penicilina no tratamento da osteomielite aguda (considerações sobre 30 casos), *Rev. Hosp. clín.* 2:1-8 (Jan.) 1947.

When such rules are observed, general and local clinical symptoms disappear rapidly, contrary to roentgenologic signs, which persist for a long time. This is due to the fact that penicillin transforms a septic necrosis into an aseptic one. The sequestrum acts like an autogenous graft which requires a certain time for its rehabilitation.

The authors report 30 cases of acute osteomyelitis in which early institution of treatment with penicillin and administration of sufficient doses prevented the development of a chronic form and avoided the necessity of an operation.

Surgical Problems in Patients with Diabetes Mellitus.—A brief review on surgical problems in patients with diabetes is presented, in which the author states that the use of penicillin has completely changed the concept of the management of carbuncles and has completely altered the approach to certain problems of the lower extremities in diabetic patients.³⁹⁵

The author states that formerly large carbuncles were a threat to the life of the patient. Treatment required wide excision and prolonged hospitalization. Now, with penicillin given intramuscularly in doses of 60,000 units every three hours, the lesion usually disappears in three to five days or becomes reduced to a small fluctuant area requiring a small incision. The author states that while carbuncles may be treated on an outpatient basis by penicillin in peanut oil or injected locally, hospitalization with intramuscular injections of penicillin is the preferred procedure.

Lesions of the lower extremities usually fall into three groups: (1) lesions which are primarily infections of a foot with adequate circulation, (2) lesions which are primarily due to defective arterial supply and (3) neuropathic ulcerations.

The use of penicillin to control infection makes possible procedures which were formerly too dangerous. Penicillin is administered in doses of 300,000 to 500,000 units daily (60,000 units every three hours) for at least twenty-four hours before operation and for five to seven days after operation. Operation above the area of gangrene and gross infection usually gives good results even when circulation is impaired. The author states that 92 transmetatarsal amputations were done, with no deaths and with satisfactory functional and anatomic results. It is stated that in cases in which one or more digits are involved, transmetatarsal amputation offers excellent insurance against later complications.

Antibiotics in the Surgery of Trauma.—A brief summary of the usefulness of the antibiotics (penicillin, streptomycin, tyrothricin and

395. McKittrick, L. S.: *Surgical Problems in Patients with Diabetes Mellitus*. Chicago M. Soc. Bull. 50:235-239 (Sept. 27) 1947.

bacitracin) in traumatic surgery is presented, based on reports from the literature and the experience at the Henry Ford Hospital.³⁹⁶

The author states that the antibiotics have not obviated the need for orthodox surgery in the prophylaxis and treatment of infected wounds, but are valuable adjuncts. Ideally, their use should be accompanied with bacteriologic diagnosis.

The most widely used antibiotics are penicillin and streptomycin. The discussion of their usefulness has been presented under the following headings: injuries of soft parts; compound fractures; burns.

The author states that at the Henry Ford Hospital, treatment of lacerations in the emergency room consists of the usual surgical procedures without antibiotics. Patients with complicated wounds receive penicillin intramuscularly in doses of 12,500 units every three hours for five days. In cases of contaminated serous cavities penicillin is administered systemically and is instilled locally (100,000 units).

Penicillin may be administered by intermittent intramuscular injection, a daily injection of a beeswax-oil preparation or orally. In the author's opinion intermittent intramuscular injection is the most reliable.

In cases with gram-negative organisms resistant to penicillin but sensitive to streptomycin the latter drug may be administered intramuscularly in doses of 1 to 4 Gm. daily.

Penicillin has not been effective in tetanus although the tetanus bacillus is inhibited in vitro, but it is a valuable adjunct in the treatment of gas gangrene.

All patients with compound fractures at the Henry Ford Hospital receive prophylactic intramuscular injections of penicillin for at least two weeks—50,000 units every three hours for the first week and half this dosage for the second.

Penicillin is useful during the acute phase of a burn if symptoms of infection are present; it is especially valuable during skin grafting. Two illustrative cases of the latter are given. The first patient received 5,000,000 units intramuscularly and 1,500,000 units locally. Attempts at grafting were unsuccessful until penicillin therapy was instituted. The patient in case 2 received 12,500,000 units intramuscularly. The author states that streptomycin should be useful in burns with pyocyanous infection.

Tyrothricin is effective against gram-positive cocci, but is suitable for topical application only. Bacitracin has been reported effective in a series of surgical infections due to cocci resistant to penicillin.

Use of Penicillin in Acute Infections of the Hand.—An evaluation of penicillin therapy in acute infections of the hand was carried out

396. Lam, C. R.: Antibiotics in the Surgery of Trauma, Am. J. Surg. **74**: 302-306 (Sept.) 1947.

in 260 unselected patients treated according to four different methods in the outpatient department of the Dundee Royal Infirmary.³⁹⁷ Results were compared with those in 200 cases of acute infections of the hand previously treated.

All patients were treated by incision adequate for free escape of pus and removal of all sloughs. Drainage was maintained for forty-eight hours by packing with gauze impregnated with penicillin cream (100 units per gram). In group 4 paraffin gauze was substituted.

The length of disability in acute infection of the hand was not appreciably shortened by penicillin therapy. The author states that this is because infections are already localized and pus is present before the patient sees a physician.

In 7 cases seen early enough to attempt to abort the infection with parenteral administration of penicillin, the attempt was successful in only 3 instances. The author states that the best treatment for threatening pulp infections is early lateral incision.

The use of penicillin oil and wax resulted in general or local reactions in 8 of 87 cases.

No benefit was observed from the parenteral use of penicillin post-operatively.

Suppurative Arthritis of Hip Joint Treated with Penicillin.—Good final results were obtained with combined local and systemic penicillin therapy in 4 cases of acute suppurative staphylococcic arthritis of the hip joint reported from Suva, Fiji.³⁹⁸

Patients ranged in age from 6 to 16 years. All cases were presumably secondary to septic cutaneous lesions. In all cases aspirated pus yielded *Staph. aureus*.

Treatment in all instances consisted of intra-articular instillation of penicillin after aspiration (9,000 to 30,000 units) on alternate days for two to four injections, systemic administration of penicillin (20,000 to 30,000 units every three hours) for seven days and extension on Thomas' splint for ten days to four weeks. In 2 cases a hip spica plaster was applied after removal of the splint.

In all cases full movements of the joint were attained. Return of full movement was attained earlier in cases without plaster, suggesting its use to be unnecessary.

From results in these cases, the following regimen of treatment is suggested: immediate exploratory aspiration of pus, with replacement by an equal volume of penicillin solution (3,000 units/cc.) on alternate days until there is "local freedom from pain and examination of pus

397. Webster, A. L.: Use of Penicillin in Acute Infections of the Hand, *Lancet* 2:610-612 (Oct. 25) 1947.

398. Gilchrist, K. J.: Suppurative Arthritis of Hip-Joint Treated with Penicillin: Report of Four Cases, *Brit. M. J.* 2:450-451 (Sept. 20) 1947

shows absence or degenerate forms only of staphylococci"; intramuscular injection of penicillin (30,000 units/cc.) every three hours for a week; immediate immobilization, with extension, maintained until the patient is asymptomatic and afebrile; bed rest for four weeks, after which active movements of the joint are to be encouraged.

Chronic Osteomyelitis in War Wounded: A Report of Two Veterans Discharged With Intractable Osteomyelitis and Successfully Treated with Local Penicillin Detergent Therapy.—From the experience in the 2 cases reported³⁹⁹ and with 37 civilian patients with chronic osteomyelitis, the authors conclude that "the mutilating treatment of osteomyelitis by radical surgery and cauterization is outmoded and should be replaced by conservative procedures employing antibiotics, as in the method described."

The method described employs a solution of penicillin in "aerosol O.T." 0.1 per cent (1,000,000 units in 50 cc.). This solution is instilled into the medullary canal by means of a T tube or a rubber catheter; 2 to 3 cc. is injected every three hours for ten days. An opening for the tube is made by excising the sinus tract down to the diseased bone and then curetting or drilling a hole.

The authors state that with the use of a detergent with penicillin there is a synergistic action on the efficiency of the latter.

Acute Suppurative Tenosynovitis Treated with Systemic Administration of Penicillin.—The effectiveness of intramuscular injection of penicillin in the treatment of acute suppurative tenosynovitis was investigated in 13 cases during 1946, and the results were compared with those in 13 unselected patients treated without penicillin in 1943.⁴⁰⁰

In 10 of the 13 patients selected for treatment the condition was frankly purulent at operation. Three of the infections were primary tendon sheath infections (infecting organism, *Streptococcus pyogenes*), 8 were finger pulp infections and 2 were superficial abscesses. The predominant organism in the secondary cases was *Staph. aureus* alone or in mixed culture.

Penicillin was started immediately after operation—12,500 units every three hours until a total of 1,000,000 units was given in ten days. The other principles of treatment were minimal incision and early active movements.

399. Grace, E. J., and Bryson, V.: *Osteomyelitis in War Wounded: A Report of Two Veterans Discharged with Intractable Osteomyelitis and Successfully Treated with Local Penicillin-Detergent Therapy*, *New York State J. Med.* **47**:2204-2205 (Oct. 15) 1947.

400. Cruickshank, C. N., and Harrison, S. H.: *Acute Suppurative Tenosynovitis Treated with Systemic Penicillin*, *Lancet* **2**:606-608 (Oct. 25) 1947.

Eight of the penicillin-treated patients attained full function, and only 1 required amputation, while of the patients treated without penicillin, none attained full function and 9 required amputation.

For the penicillin-treated patients the medium healing time was twenty-seven days (maximum thirty-eight, minimum twelve). Medium healing time in the patients treated without penicillin was sixty-one days (maximum one hundred and eighty, minimum seventeen).

It is concluded that the effectiveness of intramuscular injection of penicillin has been established by these results.

Penicillin and the Treatment of Infected Hands in Outpatients.—The efficacy of the outpatient treatment of infections of the hand by intramuscular injection, twice daily, of large doses of penicillin in aqueous solution of beeswax oil was investigated.⁴⁰¹ Seventeen patients were so treated. Results were compared with those in 168 patients treated without penicillin.

Penicillin dosage was 300,000 units in aqueous solution or 100,000 to 150,000 units in beeswax oil twice daily. The condition of patients selected for penicillin treatment was clinically more serious than that of those treated without penicillin.

The average loss of duty for the 168 patients treated without penicillin was 20.3 days; for the 17 patients treated with penicillin it was 10.9 days.

Grouped according to diagnosis, the average loss of duty was as follows: paronychia and pulp space infection—without penicillin, 21 days, with penicillin, 9.9 days; tenosynovitis—without penicillin, 17.5 days, with penicillin, 9.9 days; palmar space infections—without penicillin, 16.5 days, with penicillin, 17 days (including a patient who became reinfected, prolonging loss of duty to 41 days).

Blood level studies demonstrated that administration of 150,000 units of penicillin in beeswax oil twice daily would provide continuous blood levels averaging 0.08 units per cubic centimeter; however, the peak level with this dosage is only 0.32 units. Clinically, both this dosage and 300,000 units in aqueous solution twice daily were considered adequate.

From these results it is recommended that penicillin therapy be routine in all severe infections of the hand, both in the early stages and after necessary surgical treatment.

Chronic Osteomyelitis as the Sequel to a Gunshot Wound.—According to an article by Perkins,⁴⁰² "operation rarely does any good" and

401. D'Abreu, F.; Flood, C. M., and Hewitt, H. B.: Penicillin and the Treatment of Infected Hands in Out-Patients, *Brit. M. J.* 2:603-605 (Oct. 18) 1947.

402. Perkins, G.: Chronic Osteomyelitis, Sequel to Gunshot Wound, *Brit. J. Surg.* 34:31-34 (July) 1946.

"excluding an operation on the bone, there are two courses open to the patient; one, to accept his lot and to be resigned to periodic flares which will keep him from work for several weeks once or twice a year; and the other, to lose his limb. Many a pensioner of the last war is today thankful that he was at last persuaded to have his leg amputated." The author also says "penicillin has not in my experience been of any benefit."

Outline of the Treatment of Acute Hematogenous Osteomyelitis.—With the advent of the sulfonamide drugs and penicillin, ideas on this subject have changed considerably.⁴⁰³ It has been a change toward conservatism and away from the old tenets which demanded that an incision be made and bone chiseled away or drilled as soon as the diagnosis was made. The experience of Robertson, Hoyt and others with mounting numbers of cases emphasizes the wisdom of approaching the problem primarily from a nonoperative standpoint and reserving surgical intervention for those cases in which, in spite of adequate measures, pus fails to resorb and increasing tension and pain demand its release. Even in these circumstances surgical intervention should be minimal and for the purpose of drainage only, with as little damage to bone tissue as possible. With early diagnosis and good medical management, such cases should be few and far between.

If at all possible, the patient should be hospitalized. A complete examination should include roentgenograms of the involved part and of the chest. Laboratory work should include a complete blood count and urinalysis. The hemoglobin content and the white blood cell count should be determined daily during the early stages of the disease. In the presence of a hemolytic organism the blood picture serves as a guide for the administration of blood. Small blood transfusions up to 250 cc. depending on the age of the patient will do much to improve his resistance.

Fluid balance should be maintained by the intravenous administration of isotonic sodium chloride solution or sodium chloride and dextrose as required. In the presence of anorexia and lowered protein intake, protein hydrolysates should be added. In addition an adequate vitamin intake should be assured. Ascorbic acid, 50 mg. three times a day, thiamine hydrochloride, 5 mg. three times a day, nicotinic acid, 25 mg. twice a day, and percomorph liver oil, 10 drops three times a day, are given. When the oral route cannot be used, parenteral administration is carried out.

The involved part should be immobilized in a plaster of paris cast or other splint. This will add much to the comfort of the patient and

403. Lewin, P., and Scheman, L.: Symposium on Clinical Advances in Surgery: Osteomyelitis, S. Clin. North America 27:183-207 (Feb.) 1947.

insure rest of the part. The plaster should include at least the joints above and below the lesion to insure absolute immobility. It may be bivalved to permit observation of the part.

Chemotherapy: Of the sulfonamide derivatives, sulfadiazine is the most commonly used and the least toxic. Children will tolerate large doses. The daily dose may be calculated on the basis of 4 to 6 grains (0.26 to 0.4 Gm.) per pound of body weight. The initial dose for an adult is usually 2 Gm. followed by 1 Gm. every four hours day and night.

Blood levels should be checked frequently and an effort made to maintain a level of about 10 mg. per hundred cubic centimeters. When the drug cannot be taken orally the sodium salt of sulfadiazine may be used in initial doses of 4 to 6 Gm. intravenously and a level maintained by the administration of 1 Gm. every four to six hours. Adequate fluid intake must be maintained to avoid crystalluria, and the urine must be checked frequently for hematuria or crystalluria.

Penicillin has replaced the sulfonamide drugs to a large extent in the nonoperative treatment of osteomyelitis; however, they can be given concomitantly, and in fulminating cases it is advisable to do so. While the sulfonamide drugs are bacteriostatic in effect, penicillin is bactericidal in its action. Penicillin is administered in a dilution of 1,000 units per cubic centimeter. The average daily dose is about 120,000 units administered in equal doses every three hours day and night. It may be given intravenously, 10,000 units every two hours, or 15,000 units intramuscularly may be given every three hours. The frequent dosage is necessitated by the rapid elimination of the drug. More severe cases will require up to 400,000 units daily. Overdosage is a better rule than underdosage inasmuch as the latter may lead to a certain amount of resistance on the part of the organisms.

With the management as described, it will be noted that many lesions and even sequestrums will not go on to suppuration and that healing and resorption may occur without abscess formation.

In many instances abscesses which form will recede and absorb without drainage. It has been the practice of Lewin and Scheman to aspirate and irrigate until the return is clear when an abscess presents externally. Several grams of microcrystalline sulfadiazine or 5,000 or more units of penicillin is instilled through the same needle. Osteomyelitis caused by streptococci may never suppurate. That caused by staphylococci does so more consistently.

If for any reason the abscess does not recede and increasing tension and pain indicate more adequate drainage, a simple decortication is done with as little trauma as possible, a small square of bone being removed. No curettage or other manipulation is done. The periosteum should be cleanly incised and not stripped any further than is necessary to remove this section of bone. The wound is lightly packed with petrolatum gauze, and a plaster cast is applied.

When effusion into the adjacent joint occurs, the joint should be aspirated to determine whether a pyarthrosis exists. If such is the case the primary focus in the bone should be left alone and the joint drained surgically by adequate incision. The joint is lavaged with calcium penicillin solution containing 250 units per cubic centimeter. Petrolatum gauze is inserted loosely into the wound, down to but not through the capsule. The wound is dressed and encased in plaster.

The subsequent care should be along the lines outlined by Orr. No windows are necessary in the casts, and dressings should be done as infrequently as possible and always under strict asepsis. The wounds will take care of themselves.

Chemotherapy Before, During and After Surgery: No hard and fast rules can be laid down, but in general it has been found that the following plan of treatment is adequate. Penicillin is given in doses of 30,000 units every three hours for a period of five days preoperatively. On the patient's return from the operating room 50,000 units are administered intravenously in isotonic sodium chloride solution. This is followed by 30,000 units intramuscularly every three hours for a period of three to five days postoperatively, the temperature reaction and blood count being used as the guide.

Penicillin and sulfathiazole powder are used locally after débridement in the proportion of 10 Gm. of the sulfonamide drug to 150,000 units of penicillin. When irrigation of the wound is deemed advisable postoperatively, it is done through a tube leading into the gauze pack. A solution of calcium penicillin in distilled water is used. In certain cases a penicillin-fast organism may be encountered which will respond readily to a sulfonamide drug. In such cases sulfadiazine may be used. Frequently it appears advisable to administer both drugs.

Streptomycin has not as yet been found to be beneficial in osteomyelitis.

It must also be remembered that an optimal time for surgical intervention must be sought. Toward this end, the general condition of the patient must be brought up to the best possible level. Blood transfusions should be given to bring the red blood cell count and the hemoglobin content up and to supply immune bodies by passive transfer. When the patient's nutrition is deficient, an adequate intake should be assured, by a parenteral route if necessary.

Protein hydrolysates are available for intravenous administration. An adequate vitamin intake is necessary for the patient's general well-being, for bone repair and for capillary formation. A high vitamin, high caloric diet is the rule when the patient can take it. The surgical treatment of chronic osteomyelitis is not urgent, and the time spent in bringing the patient's condition up to an optimum level is time well spent.

PROGRESS IN ORTHOPEDIC SURGERY FOR 1946

A Review Prepared by an Editorial Board of the American Academy
of Orthopaedic Surgeons

X. CONGENITAL DISLOCATION OF THE HIP

Prepared by

A. BRUCE GILL, M.D., PHILADELPHIA

TRASK⁴⁰⁴ reports the case of a female child born at term by spontaneous delivery. Roentgenograms of the pelvis including the hip joints, made after delivery because of the presence of a small cutaneous depression at the level of the lumbosacral joint, revealed a slight outward and upward displacement of the right femur. The condition was apparently overlooked at the time of the examination, and no treatment was advised. One and a half years later the child had a complete dislocation of the right hip. There was no family history of congenital deformities. This case proves that congenital subluxation (or predislocation) of the hip may be present at birth and that the condition may be recognized by roentgenographic examination at this early date.

[ED. NOTE.—This type of dislocation probably occurs during late fetal life.]

Ensthaler⁴⁰⁵ describes 2 cases of coxitis or osteomyelitis in newborn infants who had congenital dislocation of the hips. The congenital dislocation can be differentiated from pathologic dislocation only if the congenital deformity is recognized before the coxitis has developed.

The history of the treatment of congenital dislocation of the hip has been reviewed by Hass.⁴⁰⁶

Da Gama⁴⁰⁷ states that it is possible to produce a fracture of the neck of the femur in the process of bloodless reduction even with the greatest care on the part of the surgeon and that spontaneous fractures may occur during the period of continuous extension. He reports a case. He ascribes this condition to pathologic changes in ligaments, muscles, nerves and bony structure that accompany congenital dysplasia of the hip.

404. Trask, B. W.: Congenital Dislocation of Hip: Report of Case, *Am. J. Roentgenol.* **55**:331-332 (March) 1946.

405. Ensthaler, J.: Ueber zwei Fälle von angeborener Hüftverrenkung mit Säuglingscoxitis, *Ztschr. f. Orthop.* **75**:65, 1944.

406. Hass, J.: Congenital Dislocation of Hip: Fifty Year Survey, *J. Internat. Coll. Surgeons* **9**:152-158 (Jan.-Feb.) 1946.

407. da Gama, C.: Luxação congênita do quadril: Responsabilidade médica, *Publ. méd., São Paulo* (no. 8-9) **16**:11-27 (March-April) 1945.

[ED. NOTE.—I have encountered no case similar to this. But I have observed one in which there was a prolonged delay in calcification of the femoral neck. It is understandable that in such a case fracture of an uncalcified neck might readily occur.]

Von Haberier⁴⁰⁸ expresses the belief that in many cases congenital dislocation is fully developed at the time of birth. He states that such conditions can be easily recognized at birth. He treats them by recumbency in a plaster mold or bed with the legs abducted. The child is fastened in this plaster bed with bandages and can be removed from it for bathing and change of diapers. In the past three years the author has observed 60 cases which were diagnosed during the first few days of life. In 33 of these the condition was bilateral; in 22 the left hip was involved and in 5 the right hip. There were completely developed luxations in 14 of the cases in which there was bilateral involvement and in 22 of the cases of unilateral involvement.

Von Haberier continues the treatment until the roentgenograms show a well developed acetabulum. The treatment may require from six weeks to eight months, with an average of three and a half months. He emphasizes the importance of early diagnosis and of treatment by abduction.

[ED. NOTE.—In this country we do not have adequate statistics on predislocations and complete dislocations that are recognized at birth and immediately treated. The opinion is generally accepted that early restoration of normal mechanics by complete conjugation of the acetabulum and the femoral head promotes and hastens complete cure. It has been observed, however, that in some cases predislocation is not cured within eight months after treatment is begun. This may be due to the fact that the condition has not been recognized and treated from birth, or it may be due to an innate inability of some hips to make a rapid or complete recovery even under favorable mechanical conditions.]

Compere and Schnute⁴⁰⁹ believe that the most common cause of failure to secure perfect results from bloodless reduction of congenital dislocation of the hip is the discontinuation of fixation in abduction too soon after reduction. They express the opinion that if abduction is maintained for a sufficient length of time a normal acetabulum will develop in accordance with Wolff's law. They recognize the danger of atrophy that is inherent in prolonged fixation in plaster casts and advocate the use of spreader splints and modified Denis Browne splints

408. von Haberier, G.: Neue Erkenntnisse der angeborenen Hüftgelenkverrenkung und ihrer Behandlung, *Ztschr. f. Orthop.* 75:38, 1944.

409. Compere, E. L., and Schnute, W. J.: Treatment of Congenital Dislocation of Hip, *J. Bone & Joint Surg.* 28:555-564 (July) 1946.

to maintain the required degree of abduction while permitting voluntary motion of the hips in flexion and extension.

[ED. NOTE.—If a luxation can be reduced, the reduction can be maintained by abduction combined with internal rotation in cases of marked anteversion. Dysplasia of the acetabular roof may or may not become corrected by natural growth processes. The authors' case reports and illustrations are too few to enable the reader to draw any conclusion. Maintenance of reduction does not always lead to normal development of the acetabulum. Furthermore, there is no reason to believe that long-continued abduction will bring about correction of such deformities as shortening of the femoral neck, high attachment of the capsule and pronounced dysplasia of the femoral head.]

Tavernier⁴¹⁰ discusses the various methods of treatment of old irreducible congenital dislocations of the hip. He has abandoned the use of resection of the femoral head and arthrodesis of the hip. Reconstructive plastic surgery is indicated from puberty up to 25 or 30 years of age, but the operations are merely prophylactic and are not always successful. In bilateral dislocations Tavernier operates on the one hip. If the result is good he then operates on the other hip.

[ED. NOTE.—This principle is correct because one cannot risk making two stiff hips.] If a posterior dislocation is well tolerated, the patient is usually advised to postpone operation until the symptoms become aggravated. In bilateral high dislocation with annoying lordosis and adduction deformity, double osteotomy is indicated. However, the author states that if excessive rigidity is present arthroplasty may also be considered in place of osteotomy. Resection of the nerves to the hip joint is indicated when pain is the predominating symptom, either before or after other types of operation. A typical indication for nerve resection is the instance in which the patient has had good walking ability for years in spite of the dislocation and then after a varying length of time suffers disabling pain. The nerve resection frequently enables the patient to walk again as well as he did formerly. Previously the author resected only the articular fibers of the obturator nerve, but more recently he has included the articular fibers from the sciatic nerve, with better results. Of 19 cases of nerve resection, excellent results have been obtained in 9, fair results in 8 and no improvement in 2. The operation may not only relieve pain but may also improve motion by relieving the muscle spasm which is due to pain.

[ED. NOTE.—This operation apparently has a definite usefulness in particular cases. Reconstructive operations may succeed equally well in

410. Tavernier, L.: L'énervation articulaire dans le traitement des luxations congénitales de la hanche chez l'adulte, *Lyon chir.* **41**:45-50 (Jan.-Feb.) 1946; *Rev.d'orthop.* **32**:109-116 (May-Aug.) 1946.

relieving pain by increasing the stability of the hip and thus removing chronic strain.]

From a study of 750 cases of congenital dislocation of the hip Bargellini ⁴¹¹ concludes that treatment during the first year of life, when the condition is only predislocation or subluxation, yields vastly better results than treatment at a later period. In some cases observed five years after reduction the clinical results were perfect and the roentgenograms showed only the slightest suggestion of the primary coxofemoral dysplasia. In other cases there was already evidence of persistent dysplasia of the femoral head, called by the author Calvé-Legg-Perthes disease, which eventually recovered without clinical symptoms.

[ED. NOTE.—Undoubtedly many of these hips were left with permanent deformity of the femoral head and corresponding deformity of the acetabulum which would produce symptoms in later years.]

Bargellini records excellent results after five years in 20 per cent of the cases, good results in 50 per cent and mediocre results in 30 per cent.

[ED. NOTE.—This end result study cannot be considered to be complete because the cases were under observation for only five years. Clinical symptoms may arise in many cases in which at the end of five years the condition is considered good or satisfactory because the patient is free from symptoms. The author's 20 per cent excellent results corresponds with the percentage of perfect results (perfect function and perfect or almost perfect anatomy) recorded by me. But the 50 per cent good results, which presumably means freedom from symptoms, would undoubtedly be much reduced on reexamination in later years.]

Colonna ⁴¹² describes his method of arthroplasty for congenital dislocation of the hip in children. The first stage of the procedure consists in pulling the head of the femur down completely to the level of the acetabulum. Skeletal or skin traction may be necessary for a number of weeks to secure complete stretching and relaxation of the soft tissues. When this has been accomplished, operation is performed. Through an anterolateral incision the entire capsule of the hip joint is exposed and freed from surrounding muscles. A transverse incision is then made completely through the capsule at its narrowest point or isthmus. The head of the femur is inspected. The distal margin of the severed capsule is then sutured over the head of the femur, which thus is completely enclosed in a capsular sac. The primary acetabulum is then

411. Bargellini, D.: Considerazioni su settecentocinquanta lussazioni congenite dell'anca curate con il metodo di Paci Lorenz entro il primo anno di vita e riesaminate ad oltre cinque anni dalla riduzione, *Arch. ortop.* 56:3-28 (July) 1940.

412. Colonna, P. C.: Arthroplasty for Congenital Dislocation of Hip, *J. Internat. Coll. Surgeons* 9:51-55 (Jan.-Feb.) 1946.

enlarged, deepened and rounded sufficiently to receive the entire capsule-covered head. The head is placed in the new acetabulum, the wound is closed and the lower extremity and the trunk are fixed by a plaster cast to maintain full extension and slight abduction of the hip. The cast is removed at the end of four weeks. Five to 10 pounds (2 to 45 Kg.) of traction is employed during the next few weeks. Active and passive movements are given after removal of the cast. Abduction and flexion contractures must be prevented. Walking is begun in from three to six months after the operation.

Colonna considers this operative procedure to be indicated for (1) children under 3 years of age in whom reduction cannot be obtained by bloodless manipulation or in whom redislocation has occurred after a primary reduction and (2) children from 3 to 10 years of age in whom it is possible to pull the head of the femur down to the level of the primary acetabulum. The essential contraindication is an inability to obtain preliminary stretching of soft tissues sufficient to bring the head of the femur to the level of the acetabulum. This factor is dependent largely, but not entirely, on the advancing age of the child.

Colonna describes 5 patients who have been followed for from ten to thirteen years after operation. They have stable, well formed hip joints, excellent range of active and passive motion and no limp.

[ED. NOTE.—As pointed out recently by Colonna, the best results followed the use of this procedure for unilateral dislocation in children under 8 years of age.]

Ponseti⁴¹³ analyzes results following the shelf operation in 70 cases of congenital dislocation of the hip from the service of Dr. Steindler, at Iowa State University. Seven other cases of dislocation due to infantile paralysis, spastic paralysis and suppurative arthritis are included in the report. The age of the patients at the time of operation varied from 2½ years to 36 years. In 42 cases the shelf was built over a femoral head which was placed in the primary acetabulum. In the others palliative operations were performed for irreducible dislocation. In 27 cases closed reduction had been done from one month to sixteen years before the shelf operation. In 50 cases the operation was performed with or without concomitant closed reduction.

Of 7 patients with prenatal dislocations operated on between 2½ and 5 years of age, not one had a good anatomic or functional result.

[ED. NOTE.—If these hips fall in the group which present severe deformities at birth, one should not expect to obtain good results by

413. Ponseti, I.: Pathomechanics of Hip After Shelf Operation, *J. Bone & Joint Surg.* 28:229-240 (April) 1946.

operation. They are irremediably dislocated, and only palliative operations are possible.]

Twenty-three patients under 6 years of age were operated on for postnatal dislocation of the hip. In 5 of these the femoral head was not placed in the primary acetabulum, and the results were anatomically and functionally poor.

[ED. NOTE.—These results should be expected, as the operations were only palliative.]

In 18 cases the head was in the primary acetabulum. The results were a "well developed hip" in only 1 case and a "moderate deformity of the hip" in only 3 cases. Five operations resulted in "dysplasia, not subluxation," two in subluxation and seven in "head in secondary acetabulum." The functional results were correspondingly poor. In only 4 patients was there an absence of symptoms.

[ED. NOTE.—One should obtain better results from well executed shelf or "buttress" operations in this type of dislocation. This subject is discussed in the following paragraphs.]

Thirty-one hips were operated on for postnatal dislocation. The patients were over 6 years of age. In 15 cases the shelf was formed over a head which lay in a secondary acetabulum and in 15 cases the head was in no acetabulum. The results in these 20 cases were anatomically and functionally poor. Of 9 cases in which the head was in the primary acetabulum, only 1 resulted in a moderate deformity of the hip, with freedom from symptoms, while the remaining 8 resulted in "dysplasia" or "head in secondary acetabulum," with the presence of symptoms.

Of forty-two hips operated on with the femoral head in the primary acetabulum, only six became satisfactory, one became fused after a forcible reduction and thirty-five became subluxated or dysplastic, with pain, limp, limitation of motion or all three of these symptoms. In the successful cases the head of the femur remained in the primary acetabulum; in the instances in which the operation failed it moved outward and upward. When the femoral head is situated too far from the central weight-bearing line of the body, a positive Trendelenburg sign and a limp must be present. Ponseti states that in most cases the shelf was built at the upper end of a sloping acetabular roof, and when the patient started to walk the femoral head slipped outward and upward until it came to rest beneath the newly constructed shelf.

[ED. NOTE.—I have repeatedly emphasized the importance of correcting the obliquity of the acetabular roof and of constructing the shelf as an integral part of this reflected roof so that the roof with its added extension covers snugly and accurately the entire upper portion of the head of the femur. If this operation is performed properly, the head of

the femur can never thereafter travel upward and outward. This paper demonstrates not the futility of the "shelf" operation per se but rather the poor results of inadequate surgical treatment. When the head of the femur does not lie in the primary acetabulum or cannot be placed within it by gentle manipulation, the shelf operation should be considered as a palliative procedure which cannot be expected to produce a perfect hip but which will relieve or abolish some of the symptoms, particularly pain and disability, if the operation is properly done. This paper on the end results of the shelf operation, like similar previous papers, serves chiefly to demonstrate the poor results that may be obtained by doing a good operation badly.]

SURGICAL TREATMENT OF ULCERATIVE COLITIS

GARNET W. AULT, M.D.

WASHINGTON, D.C.

AN ANALYSIS of our files on patients with ulcerative colitis to Sept. 1, 1947, has indicated that approximately 15 to 20 per cent of them have reached an advanced stage of this disease. If one is correct in assuming that 15 to 20 per cent of all patients with chronic ulcerative colitis advance to the stage of chronic medical invalidism, disability and an unemployable status, then selective surgical treatment should be offered to this group. A restoration to health and occupation should be the yardstick by which the results of surgical treatment are evaluated.

A survey of the reports of Cave,¹ Jones,² Rankin,³ Cattell,⁴ Dixon,⁵ Kiefer,⁶ Bargaen,⁷ Crohn,⁸ Bockus,⁹ Cave and Mackie,¹⁰ Dennis,¹¹

Read before the Section on Gastro-Enterology and Proctology at the Ninety-Seventh Annual Session of the American Medical Association, Chicago, June 23, 1948.

1. Cave, H. W., and Thompson, J. E.: Mortality Factors in the Surgical Treatment of Ulcerative Colitis, *Ann. Surg.* **114**:46 (July) 1941.

2. Jones, T. E.: Surgical Treatment of Ulcerative Colitis, *J. A. M. A.* **111**:2076 (Dec. 3) 1938.

3. Rankin, F. W.: Chronic Ulcerative Colitis, *South. M. J.* **34**:464 (May) 1941.

4. Cattell, R. B.: Indications for Colectomy in Ulcerative Colitis, *S. Clin. North America* **24**:656 (June) 1944.

5. Dixon, C. F.: Surgical Treatment of the Dysenteries, *Minnesota Med.* **19**:33 (Jan.) 1936.

6. Kiefer, E. D.: A Review of the Problem of Chronic Ulcerative Colitis, *Tr. Am. Proct. Soc.*, 1946, p. 487.

7. Bargaen, J. A.; Jackman, R. J., and Kerr, J. G.: Studies on the Life Histories of Patients with Chronic Ulcerative Colitis, *Ann. Int. Med.* **12**:399 (Sept.) 1938.

8. Crohn, B. B., and Rosenak, B. D.: A Follow-Up of Ulcerative Colitis, *Am. J. Digest Dis. & Nutrition* **2**:343 (Aug.) 1935.

9. Bockus, H. L., and others: Prognosis of Ulcerative Colitis, *J. A. M. A.* **111**:2078 (Dec. 3) 1938.

10. Cave, H. W., and Mackie, T. T.: Chronic Ulcerative Colitis, *South. M. J.* **31**:414 (April) 1938.

11. Dennis, C.: Surgery in Relation to Chronic Ulcerative Colitis, *Minnesota Med* **28**:228 (March) 1945.

Garlock,¹² Ravich¹³ and many others has indicated that surgical treatment will rehabilitate a greater number of patients than is generally recognized.

STATUS OF THE PATIENT

Patients who have experienced an *initial* acute fulminating attack of chronic ulcerative colitis are not considered candidates for surgery. It is felt that this disease is primarily a medical problem, and patients in this category should not be denied the opportunity to become rehabilitated by medical management. The results of the surgical treatment of early ulcerative colitis are not impressive, although I am aware of the experimental work now being done in regard to vagotomy.

Patients who have had chronic or recurrent ulcerative colitis for several years may be considered candidates for surgery. These seriously ill patients must be classified as poor surgical risks, and discretion must be exerted regarding the extent and timing of the surgical procedures.

SPECIFIC INDICATIONS FOR SURGICAL INTERVENTION

The following indications for surgical intervention are presented because it is felt that they represent a means of rehabilitating many patients.

1. *Chronic Ulcerative Colitis with Constitutional and Visceral Degenerative Changes.*—Patients with this condition have had chronic ulcerative colitis for months or years, so that they are chronic invalids. Recurrent or continuous disability is associated with their sepsis, toxemia, anemia, malnutrition and vitamin deficiencies. Amenorrhea and absence of development of the breasts and of other secondary sex characteristics will occur in young women. In both sexes the results of hepatic function tests will be altered and biopsies of the liver will show marked pathologic changes. Some of the complications such as pyoderma, recurrent cutaneous ulcers, furunculosis, neuritis and stomatitis have been classified in the past under focal infection. It is doubtful if any of these exist alone, as they are ordinarily a part of the entire disease process. They should be included in the constitutional and visceral category. A disabling polyarthrititis that has not progressed to the point of structural change should also be included in this group. A disability of 80 to 90 per cent with reference to education or employment will be present in most of these patients.

2. *Anorectal Complications.*—Patients in whom recurrent anal ulceration and perirectal infection develop in the form of abscesses and

12. Garlock, J. H.: Surgical Treatment of Intractable Colitis, *Ann. Surg.* **113**:2 (Jan.) 1941.

13. Ravitch, M. M.: Personal communication to the author.

fistulas are indeed disabled. Decreased rectal capacity from tubular stricture leads to incontinence, as does rectovaginal fistula. Incontinence following fistulectomy is common, so that local surgical treatment, except for the adequate drainage of abscesses, is unsatisfactory. Good health and employment are rarely attained by these patients until major surgical treatment solves their problems.

3. *Polypoid Degeneration and Carcinoma*.—Patients with polypoid degeneration demonstrable by repeated roentgen and proctoscopic examinations should be considered candidates for surgery. The exceptions to this rule are few if it is conceded that the potentiality for malignant degeneration is great.

4. *Obstruction and Tumor Mass*.—A diagnosis of malignant growth is favored if previous evidence of polypoid degeneration is available. However, if one is confronted with the problem of obstruction from an abdominal or an abdominopelvic mass, the character of the lesion can rarely be determined until histologic study of the resected specimen is performed. Proximal colostomy or ileostomy is advocated preliminary to resection.

5. *Perforation, Abscess and Fistula*.—A slow perforation that localizes to form an abscess should be drained. When an abdominal, pelvic or visceral fistula develops, proximal colostomy or ileostomy should be done before resection of the involved bowel or structures is attempted. These complications are a part of the disease process in the colon, and local repair is not advised, nor is it generally successful.

6. *Segmental Ulcerative Colitis*.—If one can prove by repeated proctoscopy and roentgen study that the rectum is not involved, consideration should be given to early surgical treatment of the segmental type of ulcerative colitis. This may consist of ileosigmoidostomy when the right half of the colon is involved. Anastomosis between the right transverse colon and the lower end of the sigmoid or rectum may be indicated when a segment of the left colon is involved. Simultaneous exclusion of the involved segment of the left colon by exteriorization is advised.

QUESTIONABLE INDICATIONS FOR SURGICAL INTERVENTION

The following questionable indications for surgical intervention are most controversial. The results of the surgical treatment for these phases of ulcerative colitis are not impressive. They are discussed because I personally feel that they should be abandoned.

1. *Hemorrhage*.—Acute, continuous or recurrent hemorrhage is rarely an indication for operation. A reduction in the total blood volume in most patients should be restored by replacement with whole blood, protein solutions and other intravenously administered adjuncts. Massive parenteral doses of vitamin K, vitamin C, nicotinic acid, vitamin B complex and liver are a part of this supportive treatment. Total

parenteral alimentation is indicated, and nothing is administered orally. Surgical intervention should be deferred until the patient becomes an acceptable surgical risk after response to this medical regimen.

2. *Acute Fulminating Ulcerative Colitis*.—Patients in whom an *initial* acute fulminating attack of ulcerative colitis develops should be considered medical problems. The profound sepsis, toxemia, acute malnutrition and deranged physiologic process associated with severe denudation of the colon usually result in a severe state of constitutional decline. These patients are not acceptable candidates for surgery, as past reports have indicated. The mortality is unquestionably too high, and if they survive this phase of the disease they may be operated on later with greater safety.

TABLE 1.—*Status of Operative Procedures*

Operations	Procedure	Deaths	Mortality, %
14	Ileostomy	2	14.2
4	Left colectomy	0	0
9	Total colectomy	0	0
6	Abdominoperineal	0	0
15	Miscellaneous	1	6.6
48		3	6.2

TABLE 2.—*Mortality Status of 23 Patients*

A.	Postoperative Mortality	Deaths	Mortality
	Ileostomy—perforated ileum	1	
	Ileostomy—perforated colon	1	
	Laparotomy—adhesions	1	
		3	13%
B.	Mortality of Ulcerative Colitis		
	Ileostomy—enterocolic fistula	1	
	Colostomy—inoperable carcinoma	1	
		2	8.7%

3. *Acute Perforation*.—Perforation into the free peritoneal cavity during the *initial* acute fulminating stage of ulcerative colitis is invariably fatal. A spreading virulent peritonitis accompanied with multiple abscess formation is ample evidence of the futility of treatment. This may be dramatically illustrated at autopsy when one attempts to deliver a necrotic bowel from the abdominal cavity.

SURGICAL PROCEDURE

As of Sept. 1, 1947, 120 patients were seen and 23 were operated on. The results of forty-eight major abdominal surgical operations are presented in table 1.

MORTALITY STATUS

The mortality status of 23 patients in relation to the surgical treatment and in relation to the disease is presented in table 2.

POSTOPERATIVE STATUS

The postoperative status of these 23 patients in relation to rehabilitation is presented in table 3.

COMMENT

From the results of the surgical treatment of ulcerative colitis in table 1 it is apparent that ileostomy alone can be a formidable procedure. It is hoped that a lower mortality rate will be approached in the future. Under miscellaneous procedures, segmental resections, partial colectomies, ileosigmoidostomies, operations for abdominal and visceral fistulas and explorations for obstruction from adhesions were performed. A spontaneous enterocolic fistula developed in 1 patient subjected to ileostomy. This effectively nullified the results of the operation, and the convalescent patient's death at home is correctly assigned to an active return of his disease. The development of carci-

TABLE 3.—*Postoperative Status of 23 Patients*

Status	No.	%
Restored to health.....	16	69.5
Convalescent	1	4.3
Rehabilitated	17	73.8
Postoperative mortality	3	13.0
	2	8.7
Dead	5	21.7
Unknown	1	4.3

noma (unresectable) in ulcerative colitis is an example of malignant polypoid degeneration which is indeed unfortunate.

The most encouraging aspect of this entire program was the rehabilitation status of the patients. Approximately 75 per cent of these seriously ill, disabled patients were restored to health and occupation. I doubt if I can report such a favorable rehabilitation status a few years from now, for I am acutely aware that regional enteritis affecting the ileum and jejunum has developed in some patients. However, if one can restore at least 50 per cent of these persons to health and occupation, it is an impetus to continue with the work.

915 Nineteenth Street, N. W.

ABSTRACT OF DISCUSSION

DR. JOSEPH BANK, Phoenix, Ariz.: Dr Ault has made a distinct contribution to our thinking about ulcerative colitis. There is no unanimity of opinion concerning the proper time for operation. We are faced with the problem of employing both medical and surgical measures most judiciously in this baffling disease.

It has been properly emphasized by Dr. Ault and others that mild cases or initial acute fulminating attacks are medical problems. Surgical treatment in the

latter group is hazardous. The same may be said for operation under emergency conditions. Conservative surgeons agree that some cases of segmental colitis and complications of ulcerative colitis should have the benefit of surgical intervention. These are obstruction, impending or actual perforation under certain conditions, anorectal complications, polypoid degeneration or suspected malignant growths. Few will deny the 15 or 20 per cent of medical bankrupts that Dr. Ault speaks of a chance at rehabilitation by means of surgery; but what constitutes intractability, and when does one decide that the disease has become irreversible? The barium enema and sigmoidoscopy are excellent guides. Likewise, medical complications such as severe anemia, arthritis, fecal incontinence, pyoderma and other toxic manifestations may suggest that medical management will be no longer effective. It has been pointed out, however, by many authors that neither the duration of the disease nor the character of the roentgen changes is an accurate criterion of a hopeless prognosis and that spontaneous remission may occur when one is about to give up.

In the interest of progress we may have to sacrifice an occasional spontaneous recovery or operate on a patient who might have done as well without the operation. Whether we are so inclined or not, we must embark on a period of earlier surgical intervention in order to learn whether a lower medical and surgical mortality may be achieved and perhaps also closure in a greater percentage of cases. Until such time, we should not hold out the promise of future closure when recommending ileostomy.

DR. CLARENCE DENNIS, Minneapolis: Between Jan. 1, 1934, and early 1946, 72 patients were treated nonsurgically at the University of Minnesota Hospitals, or surgical treatment was put off until all agreed that the outlook was hopeless. An effort was made in 1946 to contact all those alive; 25 could not be traced. The over-all known mortality was 40.3 per cent. The initial hospital mortality was 28 per cent. If one makes the assumption that those not followed or followed for only short periods thus far fared the same as those followed for longer periods, half were dead in five years and two thirds were dead in ten. The proportion considered improved after nonsurgical therapy is high in the first years, but it falls as the years pass, and of the 8 patients followed over ten years, only 1 is so classified. In this group of 8 patients 1 is now well only because a total colectomy was done for complicating cancer, and 2 of these and 1 of the five year group are well since they underwent vagotomy. In about the same period 41 patients were subjected to ileostomy or other direct surgical attack on the bowel, the period of postoperative observation ranging up to nine years. The initial mortality, in contrast to 28 per cent for the nonsurgical group, was 7.3 per cent. The over-all mortality was 24.6 per cent, a figure which is less disturbing under further scrutiny, for the deaths in 7 of the 10 cases were due to causes which are now preventable and if the cases were to be seen over again, the over-all mortality would be 7.3 per cent.

Five of the preventable surgical deaths were due to carcinoma of the involved colon. One of these occurred in a case considered at the time as successfully controlled on conservative management by another medical group; carcinomatosis was present, but obstruction dictated colectomy, which gave five months of life. Four patients were the victims of failure to remove the colon after ileostomy, the cancers therefore developing silently and killing in from one to nine years. In 2 additional cases the patients have undergone ileostomy and the colon is still in place; both have polyps and are unwell, and both refuse further surgical treatment. The other two preventable deaths were due to improper formation of an ileostomy opening and failure to employ prophylactic dicumarol therapy.

The surgical procedure which has proved most successful in saving life is ileostomy followed by single stage colectomy—to the rectum or including the rectum. There were 30 such colectomies performed in the period under discussion,

and many have been done since. None of these patients has died at the time of operation or since, save 1 who died of late complications of ileoproctostomy and 1 who died of carcinomatosis, as already mentioned. Twenty-two of the 30 are in good health; those who are not are in unsatisfactory condition because of proctitis or high enteritis and complications thereof or because of injudicious attempts to eliminate the ileostomy.

In the experience with the total of 113 cases mentioned, there have been 5 fatal cancers of the colon and 3 nonfatal ones; one of these was removed recently after symptoms, and 2 were found by the pathologist after routine removal of the colon. If one restricts attention to the cases with at least a five-year history of colitis, of which there were 53, the cancer rate was 15 per cent. The time of apparent onset of cancer was from nine to twenty-two years after the onset of colitis. If one is more precise and limits attention to those cases, both with and without cancer, in which there was a five-year period of observation by us, 18 per cent, essentially the same figure, is obtained.

Of the 53 patients with a five-year history of colitis, 7 had cirrhosis of the liver; also 1 patient died of cirrhosis after four years of colitis. In the five year group, therefore, including this exception, 15 per cent had cirrhosis, a point which Hoffbauer was first to make. Three of these patients had marked improvement of the cirrhosis after ileostomy or colectomy.

In the past two years, Dr. Frank Eddy, Dr. Austin McCarthy, Dr. Darrell Westover, Dr. Howard Frykman and I have been performing vagotomy in the therapy of ulcerative colitis. Thirty such procedures have been undertaken. There have been 2 surgical deaths, a rate lower than that for ileostomy, and 1 late death from unrelated causes. Twenty-five patients have been followed long enough for conclusions to be drawn, and 72 per cent are asymptomatic or improved at the present time. This is a procedure which should be used, for the present, only for the purpose of further evaluation. It is beset by many pitfalls, and the duration of the beneficial effect is not known. It is promising and relatively simple and safe, but it is not ready for general use.

DR. JOSEPH B. KIRSNER, Chicago: It seems to me that surgical intervention in 92 or 93 per cent of patients with ulcerative colitis is unusually high, if I have interpreted Dr. Dennis' discussion correctly. I think we are in agreement that stricture, obstruction, polyposis, carcinomatous degeneration and persistent anemia constitute definite indications for surgery in ulcerative colitis. However, in our experience, surgical treatment is required in only 10 to 20 per cent of patients.

Vagotomy for ulcerative colitis is perhaps a worth while experiment. Performed by careful observers, such as Dr. Dennis and his colleagues, under well controlled conditions, it may provide further knowledges of the disease. However, I do not believe that the procedure should be employed indiscriminately; the results certainly should be evaluated most carefully. I have the impression that some of the patients subjected to vagotomy have had relatively mild disease. In our experience, it is possible to maintain these persons in a satisfactory state of health by careful medical management. I should add careful and patient medical management, with attention to the individual as a whole, the improvement of nutrition and the control of infection. The natural history of chronic ulcerative colitis is one of remissions and exacerbation. I hardly need emphasize, therefore, the importance of prolonged observation in the interpretation of results. I would be interested to know the duration of follow-up observation after vagotomy in the patients treated by Dr. Dennis.

In my opinion, the medical management of ulcerative colitis remains the treatment of choice in the majority of cases at the present time.

DR. GARNET W. AULT, Washington, D. C.: I like to feel that we should be conservative in recommending surgery in the treatment of ulcerative colitis, and I expect to maintain that attitude. However, once we embark on surgical treatment, I feel that we should be most radical to obtain satisfactory results. Dr. Bank mentioned impending perforation as an indication for surgery. At present I am not sure that we have any documented evidence which will enable one to establish a diagnosis of impending perforation.

Dr. Dennis has called attention to many controversial points. I believe they must be seeing seriously ill patients with ulcerative colitis at the University of Minnesota if they are required to operate in 92 or 93 per cent of their cases. For the present, I agree with Dr. Kirsner, who feels that vagotomy in the treatment of ulcerative colitis should be limited to the patients admitted to the University of Minnesota Hospital.

Once cancer of the colon has developed in ulcerative colitis the lesion is usually unresectable. Successful outcome from resection for ulcerative colitis with cancer has been recorded very few times; therefore, we must be alert in regard to those patients who have had polypoid degeneration. We must be further alert in observing patients who have undergone ileostomy, who are getting along well, who are gaining weight and who are apparently in good condition. In general, do not allow these patients to go indefinitely without colectomy if polypoid degeneration develops. If you do, you are doing an injustice to the operation you have previously performed because malignant degeneration will many times develop when the colon is left in indefinitely.

I am going to ask if Dr. Dennis could state the exact time of follow-up in the cases in which vagotomy was performed. This seems to be an interesting point.

DR. CLARENCE DENNIS, Minneapolis: There is nothing I fear so much as that physicians will decide that this is a panacea and should be used widely. That would bring repercussions which I am sure would result in the loss of a good many patients who might otherwise do nicely. I think this subject should remain under study until we have really the answer as to whether or not it is worth doing.

The first vagotomy for ulcerative colitis was done in October 1946. We have had much too short a time to draw conclusions on what the long term results are going to be. This is one of the most important reasons for not advising the widespread use of this procedure.

DEGENERATIVE OSTEOARTHRITIS OF THE HIP JOINT

Survey of Degenerative Arthritis Secondary to Aseptic Necrosis of the Femoral Head

THOMAS HORWITZ, M.D.
INDIANAPOLIS

THIS report is based on the study of 81 cases of degenerative osteoarthritis of the hip joint, of both the primary and the secondary type. Among these 81 cases, there were 16 in which the arthritis followed aseptic necrosis of the femoral head, due to a variety of causes. The purpose of this investigation is to discuss the pathology and pathogenesis of degenerative osteoarthritis against the background of these cases, and particularly to evaluate the procedures advocated for treatment of osteoarthritis of the hip joint.

PRESENT OBSERVATIONS

CLASSIFICATION AND PATHOGENESIS

Of the 81 cases of degenerative arthritis of the hip studied in this hospital, there was a group of 33 in which the cause was obscure. In another group, comprising 28 cases, the arthritis was secondary to congenital dislocation of the hip (3 cases), congenital subluxation of the hip (4 cases), direct trauma without fracture (5 cases), preexistent rheumatoid arthritis (7 cases), pyarthrosis (1 case), slipped capital epiphysis (7 cases) and a static disturbance of a normal hip secondary to a congenitally dislocated hip on the opposite side (1 case). In a third group, of 4 cases, without evidence of aseptic necrosis, there were 2 cases of the condition in caisson workers and 2 in which there was healed fracture of the femoral neck (figs. 1, 2, 3 and 4). Finally, in 16 cases the condition was clearly secondary to aseptic necrosis of the femoral head. These included 1 case of protracted osteochondrosis of the capital epiphysis of the femur (Legg-Calvé-Perthes disease); 2 cases of healed fracture and 2 cases of ununited fracture of the neck of the femur, 2 cases following traumatic dislocation of the femoral head, 1 case secondary to caisson disease, 3 cases of so-called idiopathic aseptic necrosis and 5 cases of severe displacement of the capital epiphysis of the femur (figs. 5 and 6). Some of these cases

The work was done under a Frederick Brown Research Fellowship in Orthopedic Surgery.

From the Laboratory Division, Hospital for Joint Diseases, New York; Henry L. Jaffe, M.D., Director.

have points of special interest. For example, in the case of Perthes' disease, a drilling operation had been performed in the early stage of the disorder, at the age of 4 years, and massive avascular necrosis of the entire femoral head had been demonstrated at a second operation, eight years later. It is perhaps worth noting that in 1 of the 3 cases of so-called idiopathic aseptic necrosis there had been a history of chills and fever two years prior to operation, at which time the presence of osteomyelitis had been suspected (fig. 5). In the 5 cases of severe

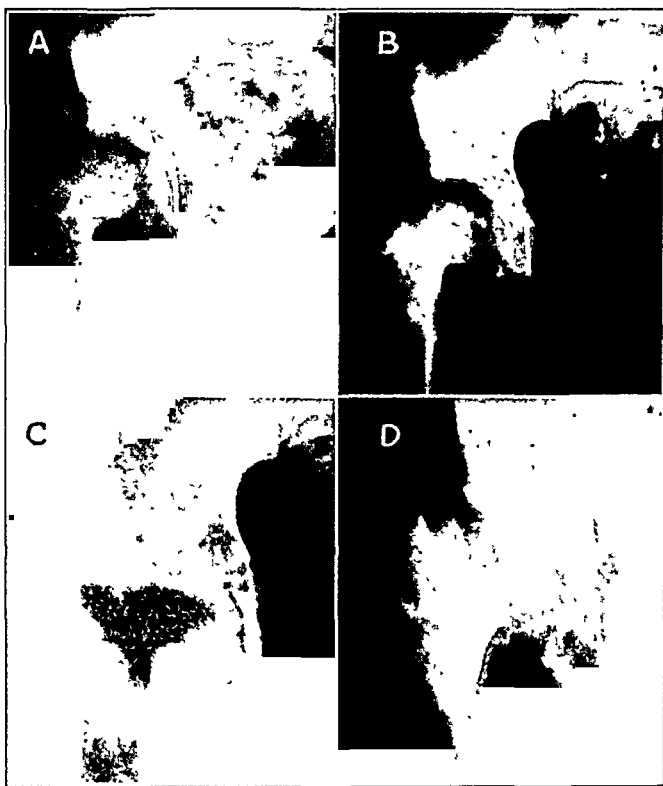


FIG. 1.—Anteroposterior roentgenograms of the right hip joint in a boy. *A*, taken when patient was 6 years of age, five months after a drilling operation intended to aid revascularization and healing of early Perthes' disease and eight months after onset of a slight limp.

B, appearance five months later, showing progression of the aseptic necrosis. The capital epiphysis of the femur is flattened and fragmented laterally and extends beyond the lateral margin of the acetabulum. The neck is widened and appears foreshortened.

C, taken when boy was 11, shows apparent healing of the original disease process. However, the capital epiphysis is greatly flattened and broad, extending out over the femoral neck superiorly to reach the great trochanter. The neck is broadened and distinctly foreshortened. The epiphysial line of the head appears regular.

D, taken when boy was 16, shows that the epiphysial line is closed. The bony structure of the upper end of the femur is of uniform density, and the articular surface appears smooth. A severe coxa vara is present, the result of several factors: retarded growth of the capital epiphysis, overgrowth of the great trochanter and almost complete absence of the neck. The eventual appearance of degenerative arthritis in the hip joint, secondary to deformation and incongruity of its bony components, is inevitable, and the patient had already manifested limp and some discomfort.

displacement of the capital epiphysis of the femur, the patients were between 13 and 16 years of age. Necrosis of the bone was incidental to vigorous attempts at manipulative reduction in 2 of these 5 cases, while in the other 3 it followed attempts at surgical correction.

CLINICAL MANIFESTATIONS

Pain was the predominant complaint, although it was often preceded by limp for several years. It was usually felt in the groin and, because of the mixed nerve supply of the hip joint, was referred along the distributions of the obturator, sciatic and femoral nerves.

Limp was incidental to pain or deformity or to both. With proliferation of bone along the margins of the acetabulum and at the juncture of the head and neck of the femur, there were progressive loss of movement, especially of extension, abduction and internal rotation, and the development of deformities of flexion, adduction and external rota-

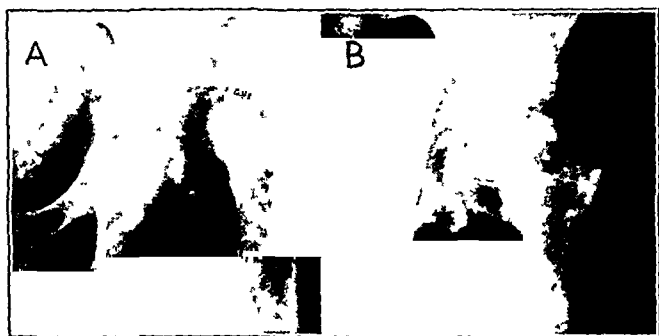


Fig. 2—Anteroposterior roentgenograms of left hip joint in a youth. *A* was taken at the age of 14, when the patient had had pain in this joint for one and one-half years. There is severe downward and posterior displacement of the capital epiphysis in relation to the externally rotated neck. There was no histologic evidence of aseptic necrosis in the material resected some time later, during open relocation of the femoral head and its transfixion to the neck by an ivory peg.

B, a roentgenogram of the same hip, taken five years later, shows a deformed and enlarged femoral head, narrowed joint space, osteosclerosis of the head and of the superior portion of the acetabulum and several radiolucent areas in the head-neck region—evidence of secondary degenerative arthritis. The bone peg is still visible and is not fully incorporated into the host bone. The opposite hip (not illustrated) in this case, which had been the site of mild displacement of the capital epiphysis, showed spontaneous healing without evidence of any residual deformity or secondary degenerative changes in the joint five years later.

tion. Secondary shortening depended on the degree of deformity of the hip and on whether there was loss of head and neck substance. The shortening was greatly exaggerated in cases of congenital dislocation of the hip and in cases of old, ununited fracture of the femoral neck. As fixation progressed, pain in the hip often diminished, although pain in the back sometimes complicated the deformity of the hip. Considerable

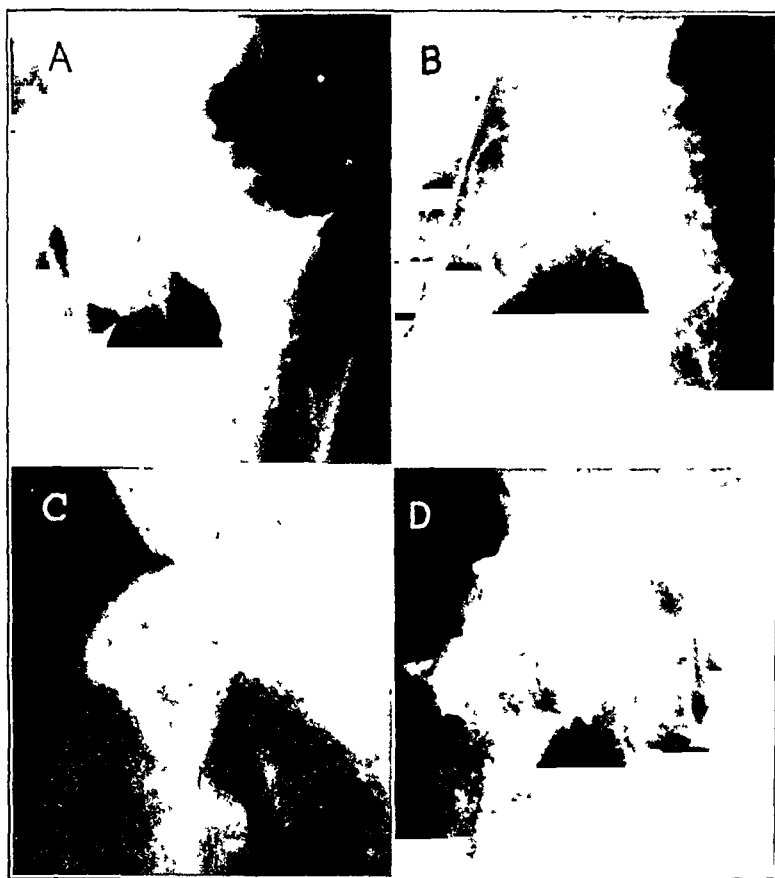


Fig. 3.—*A*, anteroposterior roentgenogram of the left hip in a woman aged 33, who had had pain in the hip for six years. There is extensive degenerative arthritis, as manifested by narrowing of the joint space, subchondral sclerosis of the femoral and acetabular components and cystification of the enlarged femoral head. The acetabulum is shallow and defective in depth. Whether this is an instance of a preexisting congenital dysplasia of the acetabulum with secondary degenerative arthritis could accurately be ascertained only by comparison with roentgenograms made earlier in life.

B, anteroposterior roentgenogram of the left hip joint in a man aged 59 with a history of fracture of the neck of the femur incurred three years previously and treated with a plaster hip spica, and with a painful hip of six months' duration. The neck is foreshortened and shows patchy sclerosis at the site of the healed fracture, and there is marginal bony proliferation at the juncture of the head and neck. Sections of material removed at the time of cheilotomy showed evidence of degenerative arthritis, but no aseptic necrosis.

C, roentgenogram of the right hip joint in a man aged 24 with a history of pain in the hip of two years' duration, three years after a fascial arthroplasty, at which time the head was merely trimmed and the acetabulum was deepened. There have been spontaneous resorption of more than one-half the remodeled head and neck and the development of a spontaneous shelf.

D, anteroposterior roentgenogram of the right hip joint of a man aged 56 with pain in both hips of several years' duration and with flexion-external rotation deformities and limitation of motion in all directions. The roentgenogram of the left hip joint showed changes identical with those in the joint illustrated. There is a degenerative arthritis with narrowing of the joint space (especially superiorly, where the bony elements are densified), hypertrophy of the femoral head and spur formation at the superior margin of the acetabulum. The bilaterally symmetric features, the age of the patient and the absence of any apparent underlying factor indicate that this case is an instance of the spontaneous, or primary, type of degenerative arthritis, probably on the basis of wear and tear or of senility.

restriction of motion in all directions was manifest in cases of intra-pelvic protrusion of the hip or in cases secondary to infectious arthritis. In such cases there may be an abduction deformity.

PATHOLOGIC OBSERVATIONS

Tissue for histologic study was available in all 81 cases. The changes noted in the articular cartilage varied from flaking and fibrillation to complete erosion of the weight-bearing portions (figs. 7 and 8). In some areas the altered cartilage showed irregularities in the number and distribution of the cells, in their staining properties and in the



Fig. 4.—*A*, anteroposterior roentgenogram of the left hip joint in a woman aged 40 with a history of pain in the left hip for twelve years and in the right hip for three years. A diagnosis of congenital dislocation of the left hip had been made and surgical intervention advised a number of years before. Distinct degenerative changes are manifested by deformity of the femoral head, osteosclerosis and marginal proliferation of bone at the superior border of the acetabulum and encircling the femoral head. The initial impression is that the deformed head accurately occupies a shallow acetabulum, with enormous proliferation of bone at the lateral border of the head and neck. Actually, the original femoral head is displaced completely out of the acetabulum, which, in turn, is occupied by an enormous mass of new bone deposited on the medial, inferior and posterior portions of the original femoral head.

B, photograph of two $\frac{1}{4}$ inch (6 mm.) slivers, sectioned in the coronal plane and through the middle of the resected left femoral head. The original head is greatly altered and comprises the upper two thirds of the specimen, while the lower third represents an enormous exostosis, which extends inferiorly and merges with the thickened inferior border of the femoral neck. The articular cartilage of the misshapen and flattened head is completely eroded, with exposure of the underlying sclerotic bone. What cartilage remains is fibrillated and extensively modified. The substance of the head is extensively cystified.

C, roentgenograms of the slivers in *B*.

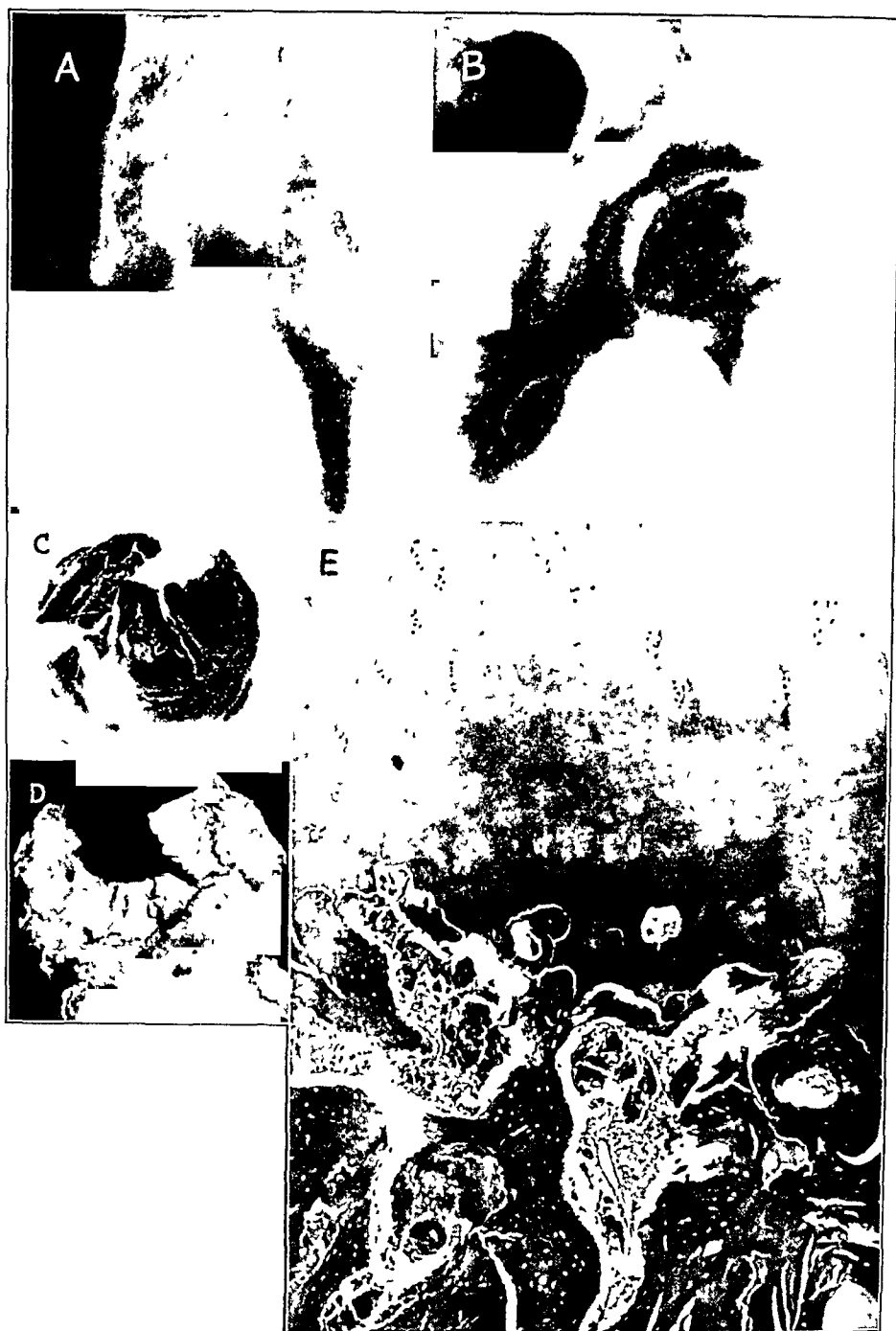


Fig. 5.—*A*, anteroposterior and, *B*, lateral roentgenograms of the hip joint in a youth aged 17, showing changes of aseptic necrosis in the femoral head. Planigrams showed more distinctly the wedge-shaped, demarcated area of sclerosis in the middle third of the head. The patient had had spontaneous and gradual onset of pain in the hip, without any injury, and, because of chills and fever, the early changes in the roentgenograms had been interpreted as those of osteomyelitis. *C*, and *D*, photographs of the articular surface of the femoral head, removed at arthroplasty. In *C*, the articular surface is extensively modified and presents

density of the matrix. In other places the degenerated cartilage was observed to have undergone fibrocartilaginous transformation. Wherever the articular cartilage was heavily modified but its calcified zone was still present, the latter was irregular, and even disrupted.

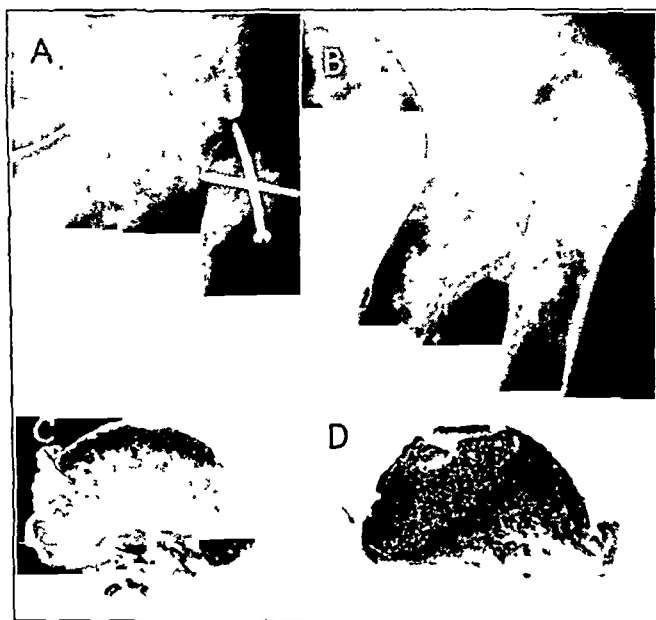


Fig. 6.—*A*, ununited fracture of the neck of the left femur in a woman aged 43 who had been injured two years previously; attempts at internal fixation and subtrochanteric osteotomy had been unsuccessful.

B, ununited fracture of the neck of the left femur in a woman aged 58, injured five years previously. The neck is almost completely resorbed, and the great trochanter is displaced upward. The capital fragment, removed at operation, showed extensive aseptic necrosis and degenerative articular changes.

C, coronal section of the femoral head in *A*, removed at reoperation, showing pronounced thinning and shredding of the articular cartilage, much fatty marrow in the head fragment and fibrous tissue at the site of nonunion. Microscopic sections revealed viable bone, no evidence of aseptic necrosis and degenerative changes in articular cartilage.

D, coronal section at the head fragment in a case of nonunion of the neck of the femur, showing advanced degeneration of the articular cartilage and a wedge-shaped area of aseptically necrotic bone.

Exostosis was a constant pathologic feature and contributed to the deformation of the bone ends of the joint. Marginally, larger or smaller exostoses ringed the articular end of the bones to variable degrees, and

furrows and folds, the results of collapse of the underlying subchondral necrotic bone. In *D*, the view of the under surface shows the central articular portion, which was necrotic and completely detached from the dense subchondral bone; the large cleft which transected the articular cap, and the subchondral sclerotic bone from the peripheral portions of the head, still attached to the cartilaginous surface. *E*, photomicrograph ($\times 15$) of an area in the peripheral portion of this specimen, showing a viable, modified articular cartilage, extensive subchondral necrosis and marrow spaces filled with cartilage, bone debris and elements of dead marrow. There was no evidence anywhere, in all of the resected material, of any recent or old inflammatory process.

acetabulum. The marrow of the femoral head was fatty or myeloid and was replaced in some areas with loose fibrous tissue. The development of cystlike cavities, which were sometimes observed in the femoral head and acetabulum, were due to degeneration in metaplastic cartilage in some cases, but were oftener caused by softening, and even liquefaction, of such areas of fibrosis in the subchondral region (figs. 7 and 8).

Collections of lymphocytes were seen in the marrow, and similar collections, some of them perivascular, were noted in the synovium. This observation is contrary to the findings of others,¹ who have emphasized the absence of these cells in degenerative arthritis. Indeed, I have observed such focal collections in the synovium in association not only with degenerative arthritis of the hip and knee joints, but with the neuropathic joints, nonspecific synovitis and a variety of other articular lesions.

Avascular necrosis of the subarticular bone is not an intrinsic part of the pathologic picture in hypertrophic or degenerative arthritis of the hip joint or of any other joint. However, it is in connection with the collapse and transformation of the femoral head associated with aseptic necrosis that one finds the most advanced manifestations of (secondary) osteoarthritis (fig. 5).

ROENTGENOGRAPHIC FINDINGS

In roentgenograms, thinning and loss of articular cartilage were demonstrated by loss of joint space. The thickened and condensed subchondral bone was manifested as sclerosis, and there was corresponding densification of the acetabulum. The cystified areas appeared as subchondral areas of radiolucency. In those instances in which the head was enlarged, it often protruded from the lateral confines of the acetabulum, and in such cases there might be an osteophytic ledge at the lateral border of the acetabulum which somewhat compensated for the incongruity. However, true subluxation sometimes existed, the head being displaced laterally and the interval between its medial surface and the acetabulum being filled in by a reduplication of the acetabular fossa and by the medial beak of the enlarged femoral head. The combination of loss of articular cartilage over the weight-bearing portion of the head, deposition of bone at the head-neck juncture and widening of the neck by actual periosteal bone formation in the region of the neck produced a mushroom or cauliflower type of deformity which was not unlike that observed in untreated or inadequately treated Legg-Perthes disease, or displacement of the capital epiphysis of the femur (figs. 7 and 8). On the other hand, the head and neck of the femur

1. Allison, N., and Ghormley, R. K.: *Diagnosis in Joint Disease: A Clinical and Pathological Study of Arthritis*, Baltimore, William Wood & Company, 1931.

might protrude deep within the acetabulum in cases of secondary arthritis complicating protrusion of the acetabulum, the great trochanter approximating the superior border of the acetabulum in accordance with the degree of intrapelvic bulge of the medial acetabular wall. The femoral head might be somewhat enlarged by marginal proliferation of bone. In these cases, the head of the femur fitted snugly and appeared well molded within the acetabulum, the medial wall of which might become conspicuously thinned, or in occasional cases might appear thickened.

TREATMENT

A variety of operative procedures were employed in the 65 cases of degenerative arthritis of the hip joint without underlying aseptic necrosis. While the follow-up records are not complete in all instances, there is sufficient evidence to indicate the deficiency of many of these procedures.

The femoral head was surgically reduced in size without the interposition of any medium in 9 cases, in 5 of which symptoms were not relieved. Autogenous fascial arthroplasty was performed in 11 cases, with failure in 5 cases and death as a result of postoperative infection in 1 case. In 9 cases, "vitallium" cup arthroplasty was done, with poor results in 8. Acetabuloplasty was performed in 5 cases, with 4 failures; drilling operation in 3 cases, with 2 failures; cheilotomy in 2 cases, with 1 failure (result unknown in the other), and bone block in 1 case, with failure. Resection of the head and neck of the femur was done in 3 cases, with partial relief of pain in 1 case and death one month after operation in 1 case; in 1 case the operation was too recent to permit evaluation of the results. The results of arthrodesis were more encouraging. Of 22 cases, solid fusion with relief of symptoms occurred in 15 and failure of fusion in 3, and no follow-up results were available in 4 cases. The results were uniformly poor after seven reoperations and good after five reoperations, in which arthrodesis terminated in fusion. In 1 of these cases, four operations were performed for the relief of pain: a bone block, a "vitallium" cup arthroplasty, a resection of the obturator nerve and, finally, arthrodesis.

Because of incomplete statistical data, no conclusions are justified from an analysis of the 16 cases in which the degenerative arthritis was clearly secondary to aseptic necrosis of the femoral head. In the 2 cases of ununited fracture of the neck of the femur and in the 1 case of so-called idiopathic aseptic necrosis, operation was too recent at the time of this study to permit evaluation of results. In the case of protracted Legg-Perthes disease, the 5 cases of severe displacement of the capital epiphysis of the femur and the case in which aseptic necrosis occurred on the basis of caisson disease, progress was not favorable after several types of reconstructive operations on the hip joint. In the

2 cases of healed fracture of the femoral neck with degenerative arthritis secondary to aseptic necrosis of the fragment of the head, fusion operations were carried out, and arthroplasty was performed in the remaining 4 cases—2 cases of so-called idiopathic aseptic necrosis and 2 secondary to traumatic dislocation of the femoral head. In no instance in this group in which arthroplasty was performed was a "vitallium" cup or any other type of cup used as an interposing medium.

PREVIOUS OBSERVATIONS

PATHOGENESIS

The literature dealing with degenerative arthritis gives a great deal of attention to the question of pathogenesis.² It is clear that in certain instances arthritis of the hip joint is primary. Plewes³ determined an underlying cause in only 51 per cent of 242 cases; Harmon⁴ inculpated a known causative factor in only 39.4 per cent of his series, while Wiberg⁵ classified 46.7 per cent of his 257 cases as instances of "secondary" arthritis. The spontaneous form may not be as common as it is usually thought to be. In the present series, the degenerative arthritis was definitely superimposed on a preexisting lesion of the hip joint in 48 of the 81 cases (59 per cent).

As demonstrated by Plewes³ in cases of displaced capital epiphysis and of Perthes' disease, secondary arthritis will appear earlier when the primary condition has been of late onset (figs. 1 and 2).

It has been observed that incongruity of articular surfaces is most striking in cases of congenital dislocation and congenital subluxation of the femoral head, conditions which may be further complicated by vascular changes in the capital epiphysis incidental to closed or open

2. (a) Allison and Ghormley.¹ (b) Nichols, E. H., and Richardson, F. L.: *Arthritis Deformans*, J. M. Research **21**:149-222, 1909. (c) Dawson, M. H.: *Chronic Arthritis*, in Nelson Loose-Leaf Living Surgery, New York, Thos. Nelson & Sons, 1935, pp. 605-644. (d) Keefer, C. S.: *The Pathogenesis and Diagnosis of Degenerative Arthritis*, M. Clin. North America **18**:947-967, 1935. (e) Collins, D. H.: *Pathology of Osteoarthritis*, Brit. J. Rheumat. **1**:248-262, 1939. (f) Bauer, W.: *Studies Pertaining to the Origin and Nature of Hypertrophic Arthritis*, Tr. & Stud. Coll. Physicians, Philadelphia **7**:1-20, 1939. (g) Sawyer, M. H., and Ghormley, R. K.: *Pathologic Study of Hypertrophic Arthritis of the Hip*, Surgery **9**:381-393, 1941. (h) Phemister, D. B.: *Etiology and Pathology of Degenerative Hip Disease*, in American Academy of Orthopaedic Surgeons Lectures on Regional Orthopedic Surgery and Fundamental Orthopedic Problems, Ann Arbor, Mich., Edwards Bros., Inc., 1947, pp. 189-198.

3. Plewes, L. W.: *Osteoarthritis of the Hip*, Brit. J. Surg. **27**:682-695, 1940.

4. Harmon, P. H.: *Arthroplasty of the Hip for Osteoarthritis Utilizing Foreign-Body Cups of Plastic*, Surg., Gynec. & Obst. **76**:347-365, 1943.

5. Wiberg, G.: *Studies on Dysplastic Acetabula and Congenital Subluxation of the Hip Joint, with Special Reference to the Complication of Osteoarthritis*, Acta chir. Scandinav. (suppl. 58) **83**:1-134, 1939.

reduction, and in cases of congenital dysplasia (undervelopment) of the acetabular roof without displacement of the femoral head (figs. 3A and 4). However, Wiberg⁵ placed too much emphasis on dysplasia of the acetabulum in the development of secondary arthritis when he attributed the condition in 25.7 per cent of his 257 cases to this origin. Plewes demonstrated that, although the acetabulum appeared shallow in most of his cases, actual measurements showed that the decrease in depth was caused by deposition of new bone on the medial wall of the acetabulum. Articular incongruity was also observed in cases of coxa vara on a congenital, metabolic or traumatic basis and in cases of protrusion of the acetabulum.

Pommer suggested that the normal use of a joint through a life of average length, without definite trauma or infection, may result in evidences of wear and tear as an expression of senescence. The observations of Heine⁶ and Beitzke⁷ suggested that some degree of osteoarthritis is universal after the age of 50, and the studies of Bauer and his co-workers^{2f} revealed that degenerative articular changes become increasingly manifest with each decade of life and are the result of increasing age and continued use. In similar anatomic studies, Meyer⁸ referred to these lesions as "attritional." Static defects in the spine and lower extremities which alter the mechanics of weight bearing influence the time of appearance and the severity of secondary arthritis of the hip. It becomes especially manifest in joints subjected to repeated occupational injury (fig. 3D).

The lesion of secondary degenerative arthritis cannot be differentiated histologically from that of primary traumatic arthritis. Key⁹ showed that an osteoarthritis may develop experimentally through a variety of means which injure or destroy the articular cartilage. This observation is consistent with the finding of degenerative arthritis as a complication of intra-articular fractures, internal joint derangements and intra-articular foreign metallic bodies. In my material, the capital fragment in 2 cases of ununited fracture of the femoral neck, even though viable and without histologic evidence of aseptic necrosis, manifested pronounced degenerative changes in the articular cartilage. Such changes could vitiate the results of reconstructive procedures which aim to preserve the apparently viable capital fragment, as in subtrochanteric (trans-

6. Heine, J.: Ueber die Arthritis deformans, *Virchows Arch. f. path. Anat.* **260**:521-663, 1926.

7. Beitzke, H.: Ueber die sogen. Arthritis deformans atrophica, *Ztschr. f. klin. Med.* **74**:215-229, 1912.

8. Meyer, A. W.: The Minuter Anatomy of Attritional Lesions, *J. Bone & Joint Surg.* **13**:341-360, 1931.

9. Key, J. A.: Experimental Arthritis: The Changes in Joints Produced by Creating Defects in the Articular Cartilage, *J. Bone & Joint Surg.* **13**:725-739, 1931.

location) osteotomy, bone grafting, with or without internal metallic (nail) fixation, and the Brackett type of reconstruction. Thus, the wisdom of examining the articular surface of the head fragment prior to these procedures becomes apparent (fig. 6). When the articular surface is found to be extensively modified, one of the reconstructive procedures which entails removal of the capital fragment or an arthrodesis would appear to be indicated.

Aseptic Necrosis of the Femoral Head as the Basis of Secondary Degenerative Arthritis.—That the femoral head is particularly susceptible to the occurrence of aseptic necrosis is attributable to the vulnerability of the blood supply to interruption by traumatic and disease processes.¹⁰ Necrosis may follow traumatic dislocation of the femoral head or fracture of the femoral neck (with or without subsequent union) (fig. 6). Indeed, Boyd and George¹¹ reported the occurrence of aseptic necrosis and complicating degenerative arthritis in a surprisingly high percentage of cases of femoral neck fractures observed from one to two or more years after injury, despite good bony union.

Aseptic necrosis may appear not only in connection with pronounced spontaneous displacements of the capital epiphysis of the femur (so-called slipped epiphysis), but after vigorous attempts at manipulative reduction or reconstructive operations, such as osteotomy of the femoral neck or arthroplasty. However, necrosis is uncommon in connection with displacement of the capital epiphysis of the femur.¹² As has been observed by Phemister and his co-workers,¹³ among others, aseptic necrosis of the femoral head may also appear in caisson workers,

10. Phemister, D. B.: Repair of Bone in the Presence of Aseptic Necrosis Resulting from Fractures: Transplantations and Vascular Obstruction, *J. Bone & Joint Surg.* **28**:769-787, 1930; Fractures of the Neck and Femur, Dislocations of Hip, and Obscure Vascular Disturbances Producing Aseptic Necrosis of the Head of Femur, *Surg., Gynec. & Obst.* **59**:415-440, 1934; Changes in Bones and Joints Resulting from Interruption of Circulation: I. General Considerations and Changes Resulting from Injuries, *Arch. Surg.* **41**:436-472 (Aug.) 1940; II. Nontraumatic Lesions in Adults with Bone Infarction; Arthritis Deformans, *ibid.* **41**:1455-1482 (Dec.) 1940.

11. Boyd, H. B., and George, I. L.: Complications of Fractures of the Neck of Femur, *J. Bone & Joint Surg.* **29**:13-18, 1947.

12. Jaffe, H. L., in Pomeranz, M. M.: Epiphyseolysis or Separation of the Capital Epiphysis of the Femur in Adolescence, *Am. J. Roentgenol.* **40**:580-597, 1938. Moore, R. D.: Aseptic Necrosis of the Capital Femoral Epiphysis Following Adolescent Epiphyseolysis, *Surg., Gynec. & Obst.* **80**:199-204, 1945.

13. Kahlstrom, S. C.; Burton, C. C., and Phemister, D. B.: Aseptic Necrosis of Bone: I. Infarction of Bones in Caisson Disease Resulting in Encapsulated and Calcified Areas in Diaphyses and in Arthritis Deformans, *Surg., Gynec. & Obst.* **68**:129-146, 1939; II. Infarction of Bones and Undetermined Etiology Resulting in Encapsulated and Calcified Areas in Diaphyses and in Arthritis Deformans, *ibid.* **68**:631-641, 1939. Kahlstrom, S. C., and Phemister, D. B.: Bone Infarcts: Case Report with Autopsy Findings, *Am. J. Path.* **22**:947-953, 1946.

although identical changes have been observed in the femoral head of persons who have never been caisson workers.¹⁴

Freund¹⁵ also called attention to cases of aseptic necrosis of the femoral head for which no cause was apparent. He saw an analogy between these lesions and osteochondritis dissecans of the knee. I, too, have observed 3 cases which seemed to belong to this category (fig. 5). However, the roentgenogram of the lesion in such cases tends to be somewhat different from that of osteochondritis dissecans. Specifically, in contrast to osteochondritis dissecans of the knee, the lesion in the femoral head is not clearly demarcated from the surrounding bone. Furthermore, in these cases of femoral aseptic necrosis, the necrotic, and only suggestively demarcated, focus is likely to become reconstituted and reunited in its bed.

If an area of aseptically necrotic bone is attached to and directly continuous with living bone, there is ingrowth of vessels, connective tissue and osteogenic elements from the viable bone, and the dead bone is gradually resorbed and replaced by new bone ("creeping substitution"). Pathologic fracture may occur between the dead and the living portion and result in collapse and delayed union or nonunion.¹⁶ The process of bone replacement may become "arrested prematurely" before its completion¹⁷; for this reason, even early recognition and the most judicious measures of protecting the affected area may fail to prevent collapse and deformity. That residual islands of dead bone may be present years after the clinical conclusion in Perthes' disease was observed histologically by Bergmann^{17b} and suggested by Sutro¹⁸ on the basis of roentgenographic findings.

Necrotic bone appears more opaque in the roentgenogram than the viable bone about it. Alterations in density result from atrophy of disuse, creeping replacement of dead bone by new, viable bone, pathologic fractures and collapse of dead bone bordering on joints, compression of dead trabeculae and infiltration of "bone sand" into the dead marrow spaces. However, if the process of resorption of the original bone keeps pace with the formation of new bone, such sclerosis may not be evident.

14. Taylor, H. K.: Aseptic Necrosis and Bone Infarcts in Caisson and Noncaisson Workers, New York State J. Med. **43**:2390-2398, 1943.

15. Freund, E.: Osteochondritis Dissecans of the Head of the Femur: Partial Idiopathic Aseptic Necrosis of the Femoral Head, Arch. Surg. **39**:323-352 (Sept.) 1939.

16. Sherman, M. S., and Phemister, D. B.: The Pathology of Ununited Fractures of the Neck of the Femur, J. Bone & Joint Surg. **29**:19-40, 1947.

17. (a) Phemister.¹⁹ (b) Bergmann, E.: The Role of Aseptic Bone Necrosis in Hip Lesions, Am. J. Surg. **63**:218-235, 1944.

18. Sutro, C. J., and Pomeranz, M. M.: Perthes' Disease, Arch. Surg. **34**: 360-376 (Feb.) 1937.

In aseptic necrosis, the nutrition of the articular cartilage becomes affected if the underlying bone is not soon replaced by normal bone. In cases of long standing, therefore, degenerative arthritis supervenes, and these changes become exaggerated with collapse and deformity of the femoral head—changes which occur when the unrecognized lesion is unprotected from weight bearing, or unfortunately, even when protective measures have been instituted in those instances in which the process of reorganization has become “arrested.” Indeed, even when the form of the femoral head is well preserved, the new articular fibrocartilage may be so imperfect that the development of a secondary degenerative arthritis is inevitable. Bergmann^{17b} stated that certain of his cases demonstrated the effect of constant irritation of the synovial membrane by gradual passage of necrotic powdered material, including spicules of bone and debris, into the joint space through an aperture in the articular cartilage. I, too, have observed such bony debris ground into the synovial membrane at, or close to, the capsuloarticular junctures.

TREATMENT

The importance of early and adequate treatment of congenital deformities of the hip joint and of disease and traumatic lesions of the hip joint which may be followed by deformity and incongruity of this joint cannot be overemphasized. On such treatment depends the prevention of the early appearance of the more advanced stages of secondary degenerative arthritis. With adequate early treatment, changes in the joints which may occur will be less severe and will appear later in life. With patients who are not required to be on their feet for long periods, a program of conservative therapy—traction, external fixation and physical therapy—may suffice to ameliorate the symptoms. But in patients who must return to an active life, entailing considerable weight bearing, the end results of conservative management are unsatisfactory.

In the light of pathologic alterations in degenerative arthritis of the hip joint, it is not difficult to understand why many of the procedures which have been recommended for the surgical therapy of this lesion have given unsatisfactory results. Drilling of the head and neck of the femur,¹⁹ implantation of a bone graft²⁰ and use of a muscle flap trans-

19. Smith, N.: Bone Drilling in the Neighborhood of Inflamed Joints and Elsewhere, *Brit. M. J.* **1**:416-417, 1890. Mackenzie, J. F.: On the Deliberate Opening of Bones as a Treatment for Rheumatoid Arthritis, *M. J. Australia* **2**: 690-691, 1932; Osteoarthritis of the Hip and Knee: Description of Surgical Treatment, *Brit. M. J.* **1**:306-308, 1936. Simpson, W. C.: Painful Osteoarthritis of the Hip: A Surgical Treatment, *Proc. Staff Meet., Mayo Clin.* **12**:577-579, 1937.

20. Graber-Duvernay, J.: Un traitement nouveau de l'arthrite chronique de la hanche: Le forage de l'épiphyse fémorale, *J. de méd. de Lyon* **13**:531-540, 1932.

plant into the femoral neck,²¹ as measures of "revascularizing" the femoral head, have not proved sound procedures. That improvement following drilling, when it does occur, is often transitory has been recently reported by a proponent of this procedure.²² The histologic sections from several cases of Perthes' disease of degenerative arthritis treated by multiple drillings indicate that such drill holes persist for years, become filled with connective tissue and in no way modify the progress of these disease processes. Nor is it clear how a piece of transplanted bone, avascular in itself, or a muscle flap can help in the process of revascularization. Jaffe,²³ in unpublished experiments, observed that muscle transplants into the marrow cavity of long bones in laboratory animals underwent fibrosis.

Cheilotomy,³ in which marginal excrescences are removed, does not serve to increase the adaptability of the altered femoral head within the acetabulum. Experience with partial resection of the acetabulum²⁴ has not been satisfactory, and this procedure is no longer employed by its original proponent in this country.²⁵ Subtrochanteric osteotomy,²⁶ which theoretically serves to alter the lines of weight bearing and to rotate the femoral head, fails to modify the essential lesions of the hip in any way. Relief in a series of 15 patients thus treated, with adequate follow-up records, which I have studied, was not uniform and, when it was secured, was often transitory. The bone block²⁷ attempts to relieve pain by limiting abduction in a condition which is characterized by progressive adduction deformity, and it does not alter the pathologic lesion or its progress.

21. Venable, C. S., and Stuck, W. G.: Muscle-Flap Transplant for the Relief of Painful Monarticular Arthritis (Aseptic Necrosis) of the Hip, *Ann. Surg.* **123**:641-655, 1946.

22. Henderson, M. S.: Bone Drilling in Osteo-Arthritis of the Hip, in *American Academy of Orthopaedic Surgeons Lectures on Regional Orthopedic Surgery and Fundamental Orthopedic Problems*, Ann Arbor, Mich., Edwards Bros., Inc., 1947, p. 223.

23. Jaffe, H. L.: Personal communication to the author.

24. (a) Hey-Groves, E. W.: Surgical Treatment of Osteoarthritis of the Hip, *Brit. M. J.* **1**:3-5, 1933. (b) Smith-Peterson, M. N.: Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum and Coxa Plana by Means of Acetabuloplasty, *J. Bone & Joint Surg.* **18**:869-880, 1936.

25. Smith-Peterson, M. N.: Cup Arthroplasty, read before the Section on Orthopedic Surgery, New York Academy of Medicine, March 21, 1947.

26. McMurray, T. P.: Osteoarthritis of the Hip Joint, *J. Bone & Joint Surg.* **21**:1-11, 1939.

27. L'Episcopo, J. B.: Bone Block for Painful Hips, *J. Bone & Joint Surg.* **20**:901-911, 1938.

While some investigators²⁸ have obtained good results with arthroplasty using autogenous fascia, others have failed to do so. The possibility of gradual resorption of the remodeled head and neck has been emphasized²⁹ (fig. 5 E). Use of the "lucite" cup (Harmon⁴) showed that resorption of the neck also occurs after cup arthroplasty, and, in the case of use of the "vitallium" cup, favorable reports of which have been submitted by Smith-Peterson³⁰ and others,³¹ descent of the cup on the greater trochanter indicates this complication. It is difficult to remove all of the diseased subchondral tissue in advanced degenerative arthritis and yet to leave sufficient head and neck not to compromise the mechanics of the new hip joint or to avoid the possibility of secondary aseptic necrosis. In addition, the remaining central portion of the neck is not particularly suited architecturally to bear the brunt of weight bearing, especially in cases of degenerative arthritis, in which the bone at a distance from the articular surface is always atrophic (fig. 8 B). For these reasons, arthroplasty does not appear to be a suitable procedure in the treatment of advanced degenerative arthritis of the hip joint. However, Badgley^{31c} reported good results in 50 per cent of cases after "vitallium" cup arthroplasty when the technical principles described by Smith-Peterson were rigidly observed.

Obturator neurectomy³² for partial desensitization of the hip joint, and complete denervation of this joint by division of its obturator, femoral and sciatic nerve supply^{32a} or by rhizotomy of the lumbar nerves,³³ in addition to not uniformly relieving the pain of osteoarthritis, may not even be without ill effect, in the light of the experi-

28. (a) HaHock, H.: A Study and End Result Report of Seventy Arthroplasties and Reconstruction Operations on the Hip Joint, Surg., Gynec. & Obst. **68**:106-112, 1939. (b) Smith, H., in discussion on Baker, L. D., and Waters, C. H.: Vitallium Cup Arthroplasty of the Hip, Arch. Surg. **44**:531-539 (March) 1942.

29. Phemister.¹⁰ Hallock.^{28a}

30. Smith-Peterson, M. N.: Arthroplasty of the Hip: A New Method, J. Bone & Joint Surg. **21**:269-288, 1939; footnote 25.

31. (a) Baker, L. D., and Waters, C. H.: Vitallium Cup Arthroplasty of the Hip, Arch. Surg. **44**:531-539 (March) 1942. (b) Becker, W. H.: Cup Arthroplasty of the Hip, Proc. Staff Meet., Mayo Clin. **19**:561-568, 1944. (c) Badgley, C. E.: Arthroplasty of the Hip for Degenerative Hip Disease, in American Academy of Orthopaedic Surgeons Lectures on Regional Orthopedic Surgery and Fundamental Orthopedic Problems, Ann Arbor, Mich., Edwards Bros., Inc., 1947, pp. 207-222.

32. (a) Cottini, G. F.: El tratamiento del dolor en la artrosis deformante de cadera por lá neurotomia del obturador (operación de Selig), Rev. Asoc. méd. argent. **59**:884-891, 1945. (b) Mallet-Guy, P., and de Mourgues, G.: Arthrite chronique de la hanche traitée par section endopelvienne du nerf obturateur, Lyon chir. **37**:262-264, 1941-1942.

33. Karlen, A.: Division of Fourth Lumbar Nerve Roots in Treatment of Arthritis Deformans of Hip, Acta chir. Scandinav. **90**:410-418, 1944.

mental work of Corbin and Hinsey.³⁴ These authors produced neuroarthropathies of the hip joint by section of the lumbosacral dorsal nerve roots and lumbar sympathectomy in animals whose activities were unrestricted. However, good results have been claimed after section of the obturator nerve for the relief of pain following arthroplasty, while the total denervation operation was recommended by Tavernier³⁵ for the relief of pain in adults with congenital dislocation of the hip, either alone or in conjunction with other operations.

Arthrodesis³⁶ has been offered as a dependable method of achieving a painless, stable joint in the treatment of unilateral degenerative arthritis of the hip joint, and the follow-up study in the present cases sustains this view. Methods of arthrodesis vary, but are clearly not always reliable in securing bony fusion; largely because of the difficulty of accurate postoperative fixation, which must often be prolonged. The combination of arthrodesis with nail fixation in one stage,³⁷ or in two stages, as advocated by Watson-Jones^{36b} and by Haggart,^{36g, h} may be the answer to this problem. While extra-articular fixation of the hip joint by means of a three-flanged nail alone has been suggested in cases in which surgical fusion cannot be tolerated, particularly in cases of obese patients,³⁸ it should be recognized, as it is by the proponents of this procedure, that the existing deformity will persist, that motion will not be completely eliminated and that pain may not be completely

34. Corbin, K. B., and Hinsey, J. C.: Influence of the Nervous System on Bone and Joints, *Anat. Rec.* **75**:307-317, 1939. Corbin, K. B.: Alterations in the Hip Joint After Deafferentation, *Arch. Surg.* **35**:1145-1158 (Dec.) 1937.

35. Tavernier, L.: Le traitement des luxations congénitales invétérées de la hanche, *Rev. orthop.* **32**:109, 1946; abstracted, *Internat. Abstr. Surg.* **84**:365-368, 1947.

36. (a) Henderson, M. S., and Pollock, G. A.: Surgical Treatment of Osteoarthritis of the Hip Joint, *J. Bone & Joint Surg.* **38**:923-931, 1940. (b) Watson-Jones, R.: Arthrodesis of the Osteoarthritic Hip, *J. A. M. A.* **110**:278-280 (Jan. 22) 1938; (c) Discussion on Treatment of Unilateral Osteoarthritis of the Hip Joint, *Proc. Roy. Soc. Med.* **38**:363-368, 1944. (d) Bosworth, D. M., in discussion on Harmon,⁴ (e) Schumm, H. C., in discussion on Harmon,⁴ (f) Karlen, A.: A Clinical Study of Arthrodesis for Arthritis Deformans of the Hip Joint, *Acta chir. Scandinav.* (supp. 96) **91**:1-191, 1944. (g) Haggart, G. E.: Degenerative Arthritis of the Hip Joint Treated by One or Two Stage Arthrodesis with Metal Fixation (Watson-Jones), *J. A. M. A.* **128**:502-506 (June 16) 1945; (h) Degenerative Disease of the Hip Joint Treated by Arthrodesis, in *American Academy of Orthopaedic Surgeons Lectures on Regional Orthopedic Surgery and Fundamental Orthopedic Problems*, Ann Arbor, Mich., Edwards Bros., Inc., 1947, pp. 201-206.

37. Dickson, J. A., and William, L. J.: Arthrodesis of the Hip Joint in Degenerative Arthritis: A Modified One-Stage Procedure with Internal Fixation, *J. Bone & Joint Surg.* **45**:687-696, 1947.

38. Watson-Jones,^{36b} Burns, B. H.: Fixation of the Osteoarthritic Hip by Nailing, *Lancet* **1**:978-980, 1939.

relieved or progressive deformity prevented thereby. For this reason, the latter procedure should be reserved for cases in which there is only a little residual, and painful, motion. Indeed, when surgical arthrodesis is combined with nail fixation, additional external fixation is necessary. In an attempt to secure some degree of fusion, which the extra-articular nail alone does not assure, Patrick³⁹ utilized a fibular graft in addition to the nail, both being inserted through the lateral aspect of the femur. This procedure is similar to that recommended by Harris⁴⁰ for arthrodesis of the hip joint. The ischiofemoral graft-subtrochanteric osteotomy advocated by Brittain⁴¹ will, in addition to its theoretic advantages over other methods of arthrodesis, allow for the simultaneous correction of a resistant adduction deformity. To overcome the vicious action of the powerful adductor muscles of the thigh, Pease⁴² suggested the use of section of the obturator nerve by the intrapelvic route as a supplementary procedure to arthrodesis.

The conservative management of aseptic necrosis of the femoral head consists in protecting the affected part from direct weight bearing until the head has become fully revived. In cases in which the process remains static or is progressive, surgical measures must be resorted to. Despite reports of good results following the use of "vitallium" cup arthroplasty in the treatment of aseptic necrosis of the femoral head,⁴³ on the basis of the pathologic observations in these cases, this procedure does not appear wise. This conclusion appears to be sustained by the clinical experience of Pridie⁴⁴ and associates. An appreciation of the extent of the lesion, which may affect the entire femoral head and much of the neck, and of the tardiness and occasional incompleteness of its replacement by normal osseous tissue, makes it evident that such a head, remodeled surgically, cannot be expected to sustain the functions of a hip joint normally and that it may collapse. As Bergmann^{17b} suggested, an aseptically necrotic femoral head should

39. Patrick, J.: Pin and Graft Arthrodesis for Osteoarthritis of the Hip, *Lancet* 2:9-11, 1946.

40. Harris, R. J.: Arthrodesis of the Hip Joint: A New and Simple Operation, *S. Clin. North America* 23:1412-1428, 1943.

41. Brittain, H. A.: Architectural Principles in Arthrodesis, Baltimore, Williams & Wilkins Company, 1942.

42. Pease, C. N.: Fusion of the Hip in Children: Chandler Method, read before the Fourteenth Annual Meeting of the American Academy of Orthopaedic Surgery, Chicago, Jan. 25-30, 1947.

43. Badgley,^{31c} Smith-Peterson, M. N.; Larson, C. B.; Aufranc, O. E., and Law, W. A.: Complications of Old Fractures of the Neck of the Femur: Results of Treatment by Vitallium-Mold Arthroplasty, *J. Bone & Joint Surg.* 45:41-48, 1947.

44. Girdleston, G. R.; Watson-Jones, R.; Stamm, T. T., and Pridie, K. H.: Discussion on Treatment of Unilateral Osteoarthritis of the Hip-Joint, *Proc. Roy. Soc. Med.* 38:363-368, 1945.

be considered as an autogenous bone graft, which can be revived only from the surrounding viable bone. How better to secure this replacement than by exposing the diseased femoral head to revitalization, not only from the neck side but from the acetabular side as well, as in arthrodesis? It would appear that arthroplasty, if truly necessary, should be deferred until the necrotic head is fully reconstructed.

Cases in which degenerative arthritis of the hip joint is bilateral pose a special problem. The condition is usually more advanced and painful on one side, and it is possible that surgical fusion of the joint on that side might lessen the burden on the less affected side and thus retard the progress of the condition there. If the opposite hip must be treated, arthroplasty is considered the procedure of choice, and in this country the "vitallium" cup procedure is most favored at this time. The procedure of pseudarthrosis (Girdlestone⁴⁴ and co-workers) and of resection of the head and neck (Hey-Groves^{24a}) have met with considerable success in the hands of certain British surgeons. Plewes³ reported remarkable results following excision of the head and neck of the femur, for he observed complete relief of pain in 20 of 23 cases and diminished pain after operation in 3, with stable joints in all cases at the end of two years and an average shortening of only $1\frac{5}{8}$ inches (41 mm.). Stamm and associates⁴⁴ modified this procedure by adding to it a Schanz type of osteotomy, the shaft being placed at right angles to the intertrochanteric line, so as to restore the abductor mechanism and to give motion in a horizontal axis, both procedures being performed in one stage. Batchelor⁴⁵ employed the Schanz type of osteotomy six to eight weeks after excision of the femoral head and neck and avoided the use of external fixation by fixing the fragments effectively with a metallic plate. There have been sporadic case reports on this procedure in this country. Milch⁴⁶ employed a Lorenz type of osteotomy, followed by resection of the head and neck at a second stage, and reported the results in 1 case. Blount⁴⁷ illustrated with a case in which he performed a resection of the neck, so as to create a pseudarthrosis, and a subtrochanteric osteotomy, followed by effective fixation with a blade plate, at the same operation.

SUMMARY

Degenerative arthritis of the hip joint was studied in 81 cases. One cause, or a combination of causes, was found in some cases. In other

45. Batchelor, J. S.: Excision of the Femoral Head and Neck in Cases of Ankylosis and Osteoarthritis of the Hip, *Proc. Roy. Soc. Med.* **38**:689-690, 1945.

46. Milch, H.: Resection of the Femoral Neck and Pelvic Support Osteotomy for Ankylosis of the Hip, *Surgery* **13**:55-61, 1943.

47. Blount, W.: Blade-Plate Internal Fixation for High Femoral Osteotomies, *J. Bone & Joint Surg.* **41**:319-339, 1943.

cases, degenerative arthritis seemed to occur spontaneously, without any apparent underlying cause.

The pathologic anatomy as observed in these cases was the same whether the degenerative arthritis appeared spontaneously or as a complication of, or sequel to, other lesions of the hip joint. Proliferation of bone at the juncture of the head and neck of the femur and denudation of the articular surface of the weight-bearing portion of the femoral head produced a flattened, mushroom-like head, not unlike the residual deformity in Legg-Perthes disease and in displacement of the capital epiphysis of the femur. Deformity of the head of the femur and thickening of the femoral neck as the result of the periosteal deposition of bone accounted for the roentgenographic and clinical features of degenerative arthritis of the hip joint.

Early and adequate treatment of congenital deformities of the hip joint and of lesions which may be followed by deformity and incongruity of the joint is emphasized in order to prevent the appearance of the more disabling stages of secondary degenerative arthritis.

In patients requiring surgical treatment, arthrodesis appears to be the most reliable method of effecting a good functional result, that is, freedom from pain and from recurrence of symptoms, further disability and deformity. Of 65 cases of degenerative arthritis of the hip joint without underlying aseptic necrosis, arthrodesis was carried out in 22, with a good functional result in 15. Other surgical procedures failed to give uniformly good results in 27 of 43 cases; there were 2 postoperative deaths. In 12 cases more than one operation was carried out. The results were poor in 7 cases and good in 5 cases, in which arthrodesis terminated in fusion.

424 Hume-Mansur Building.

PRESENT STATUS OF THE INJECTION TREATMENT OF HERNIA

AMOS R. KOONTZ, M.D.
BALTIMORE

SINCE January 1936 I have been attempting to evaluate the injection method of the treatment of hernia. By that time, so many papers reporting favorable results with the method had been published that anyone interested in hernia was forced to look into the method or at least could no longer ignore it. I therefore started using the method in two hospital clinics and also used it in a few private patients. My early experiences with the method were published in March 1941.¹ Then the war came, with the disruption of civilian pursuits that war always entails, and since returning from the war I have tried to pick up some of the loose threads, take advantage of the passage of time and form an estimate of just where the method stands today.

Obviously in a paper on the present status of the injection treatment of hernia there is no place for a discussion of the history or rationale of the procedure, the indications and contraindications, the technic of injection, solutions used or complications. All these have been discussed many times and in many published articles and also in textbooks on the subject. During the decade roughly approximating the 1930's, many apparently unbiased articles appeared on the subject of the injection treatment of hernia, and considerable enthusiasm was developed for the procedure. Bratrud,² Rice,³ Fowler,⁴ Harris and

1. Koontz, A. R.: Experiences with the Injection Treatment of Hernia, South. M. J. **34**:297, 1941.

2. Bratrud, A. F.: The Ambulant Treatment of Hernia, Journal-Lancet **53**: 673, 1933; Minnesota Med. **16**:446, 1933; **18**:441, 1935; Ann. Surg. **105**:324, 1937; Wisconsin M. J. **36**:34, 1937; in Nelson Loose-Leaf Living Surgery, New York, Thos. Nelson & Sons, 1937; Hernia in Industry, S. Clin. North America **22**:1091, 1942.

3. (a) Rice, C. O.: The Injection Treatment of Hernia, Minnesota Med. **17**: 248, 1934; (b) The Rationale of the Injection Treatment of Hernia, *ibid.* **18**:623, 1935; (c) Hernia: Its Cure by the Injection of Irritating Solutions, J. Iowa M. Soc. **26**:279, 1936; (d) Complications Associated with Treatment of Hernia: Injection Versus Operative Treatment, Minnesota Med. **24**:206, 1941. (e) Rice, C. O., and Larson, L. M.: Technic for the Injection Treatment of Hernia, South. Surgeon **5**:227, 1936; (f) Complications and End-Results Associated with the Injection

White,⁵ McKinney,⁶ McMillan and Cunningham,⁷ Manoil,⁸ Crohn⁹ and others reported excellent results with large series of cases and forced the method into a position in which it could no longer be condemned without a hearing. During the past six years the publications on the subject have diminished markedly in number. Undoubtedly, this is in large part due to the war. It is apparent also from personal communications from some of the former protagonists of the method that it is partly due to a waning of enthusiasm on the part of those who had published results during the preceding decade. In view of this it would seem that it is time to take stock and see whether the method should be continued in certain cases or entirely discarded.

First, I shall evaluate as nearly as possible the results obtained from the injection treatment of hernia. It is even harder to get

Treatment for Hernia, *ibid.* 5:390, 1936; (g) Fate of the Hernial Sac in Hernia Treated by the Injection Method, *West. J. Surg.* 44:428, 1936. (h) Rice, C. O., and Mattson, H.: Histologic Changes in the Tissue of Man and Animals Following the Injection of Solutions Intended for the Cure of Hernia, *Illinois M. J.* 70:271, 1936; (i) Injection Treatment of Hernia, Philadelphia, F. A. Davis Company, 1937.

4. Fowler, S. W.: Experience with the Injection Treatment of Hernia, *M. Rec.* 141:207, 1935; Technic of Hernial Injection Treatment, *ibid.* 141:387, 1935; Pioneers in Hernia Injection, *ibid.* 146:481, 1937; Undescended Testicle Contraindicates Injection Treatment of Hernia, *Clin. Med. & Surg.* 44:124, 1937.

5. Harris, F. I., and White, A. S.: (a) The Injection Treatment of Hernia, *Surg., Gynec. & Obst.* 63:201, 1936; Injection Treatment of Hernia: Its Experimental Basis, *California & West. Med.* 45:382, 1936; (b) Injection Treatment of Hernia: Its Present-Day Status, *ibid.* 45:391, 1936; (c) Length of the Inguinal Ligament, *J. A. M. A.* 109:1900 (Dec. 4) 1937; (e) The Truss in Relationship to Diagnosis and Injection Treatment of Inguinal Hernia, *Am. J. Surg.* 36:443, 1937; (f) Injection Treatment of Hernia: A Critical Analysis of the Failures, Recurrences and Complications, *ibid.* 37:263, 1937; (g) The Injection Treatment of Reducible Inguinal Hernia in Children, *Arch. Pediat.* 54:665 (Nov.) 1937; (h) Evaluation of the Injection Treatment of Hernia: A Statistical and Analytical Study, *J. A. M. A.* 111:2009 (Nov. 26) 1938.

6. McKinney, F. S.: An Evaluation of the Results of the Injection Treatment of Inguinal Hernia: A Review of the Employment of This Method at the University of Minnesota Hospital, *Ann. Surg.* 105:338, 1937.

7. (a) McMillan, W. M., and Cunningham, D. R.: The Injection Treatment of Reducible Hernia, *J. A. M. A.* 106:1791 (May 23) 1936. (b) McMillan, W. M.: The Injection Treatment of Hernia: An Evaluation Based on Five Years' Experience, *Indust. Med.* 8:36, 1939.

8. Manoil, L.: Histologic Effects of Various Sclerosing Solutions Used in the Injection Treatment of Hernia, *Arch. Surg.* 36:171 (Feb.) 1938; Evaluation of the Injection Treatment of Hernia in Older Patients: A Three Year Statistical Analysis, *ibid.* 41:114 (July) 1940.

9. Crohn, N. N.: The Injection Treatment of Hernia, *J. A. M. A.* 108:540 (Feb. 13) 1937.

reliable data on the number of recurrences following injection than on those following operation. The incidence of recurrences reported by various authorities varies from 100 per cent to 1 per cent. Undoubtedly a great many of the statistics published have been based on cases in which injection was entirely too recent. Obviously there is something wrong with the wide discrepancy. It is almost certain that those who reported the low percentage of recurrences had the facts somewhat colored by their optimism. On the other hand, the high percentage of recurrences reported by others makes one wonder whether the method was given adequate trial by them or whether it was used in properly selected cases. It is impossible to arrive at the truth from these figures.

Some authorities, Maier¹⁰ and Imes,¹¹ go so far as to state that they do not believe that the injection method has any place in the treatment of hernia. Maier, in operating on patients who had previously received injections, found that the tissues showed notable fibrotic changes and had lost all their resiliency, which interfered considerably with normal healing. His recurrence rate was higher than in cases in which injection had not been previously given. My experience does not parallel that of Maier. It is true that a great deal of scar tissue is found at operation on patients who have received injections. This is also true in cases in which previous operations have been performed. I could detect no pronounced difference in the resiliency of the scar tissue. Scar tissue of any sort is notably nonresilient. Indeed, in operating for a recurrent hernia (previously operated on) not only does one encounter a large quantity of scar tissue but there is often also an appreciable distortion of the anatomy, which is not found in operations on hernias that have simply received injection treatment. I have no figures on the comparative recurrence rate, but it is well known that the recurrence rate after operation for recurrent hernia (previously operated on) is higher than that after primary operation, and one would expect the same to be true after operations on hernias previously treated by injection.

In 1940 the report¹² of the Council of Pharmacy and Chemistry of the American Medical Association stated that "the weight of evidence is preponderously in favor of acceptance of the injection

10. Maier, R. L.: The Present Status of the Injection Treatment of Hernia, *Ann. Surg.* **122**:85, 1945.

11. Imes, P. R.: Personal communication to the author.

12. Present Status of Injection Treatment of Hernia, report of the Council on Pharmacy and Chemistry of the American Medical Association, *J. A. M. A.* **115**: 533 (Aug. 17) 1940.

method of treatment of hernia in carefully selected cases" and further stated:

The Council now concurs in the opinion that the method involves less danger of serious complications than surgery when employed only in selected cases of hernia by those skilled in the injection of suitable standardized solutions of known composition and action.

Since then there has been no report of the Council on the method.

It is the general consensus that better results are obtained with young persons than with old. Harris and White,⁵⁸ who have had a large experience with the injection method in children, stated that the results have been uniformly good. Riddle¹³ stated that he has never had a failure in a child.

Some of the strongest advocates of the method a decade ago have considerably modified their views with regard to it. Rice^{3a} in 1941 stated that "the injection treatment of hernia should have a place in our surgical armamentarium." Recently¹⁴ he has stated that he feels that the method has a definite, though limited, value and that he would consider using it only in young, thin persons. Harris¹⁵ stated that it has a small but limited use in so-called potential hernias and in early complete inguinal hernias. Crohn¹⁶ has abandoned the method and considers it of possible use only in small reducible indirect inguinal hernias.

On the contrary, Levy¹⁷ wrote that "in reducible indirect hernia, completely controlled by a truss, with the external ring less than 3 cm. in diameter, recurrences were under 10 per cent." Aldrich¹⁸ stated that he does not think that his recurrence rate with the injection method in selected cases runs as high as the average recurrence rate after surgical treatment.

Slobe¹⁹ wrote that the injection method

. . . can be used in many instances where surgery is contra-indicated as in the aged and infirm or in those who have serious constitutional ailments. Its use as a palliative measure with truss-wearing merits emphasis. The treatment of individuals with relaxed rings as potential hernias constitutes a field for the injection method which has many potentialities not yet adequately explored.

13. Riddle, P.: Personal communication to the author.

14. Rice, C. O.: Personal communications to the author.

15. Harris, F. I.: Personal communication to the author.

16. Crohn, N. N.: Personal communication to the author.

17. Levy, L. H.: A New Hernia Injection Solution, with the Use of Vitamin C, *M. Rec.* **155**:65, 1942.

18. Aldrich, R. H.: Personal communication to the author

19. Slobe, F. W.: The Injection Treatment of Hernia, *Indust. Med.* **4**:226, 1935; **10**:145, 1941.

He also stated that "the present trend is reducing its use as a curative method but increasing its use as a palliative measure."

Archer²⁰ used the injection method as a cure in certain cases and to supplant a truss in others. He stated that he can keep most hernias cured if the patient will wear his truss in the daytime. In many cases in which a cure cannot be hoped for much can be done to alleviate the symptoms and to improve the general health.

McMillan²¹ in 1939 stressed the palliative value of the injection method and pointed out that when recurrences do occur a few more injections will usually take care of them while recurrences after surgical treatment require, for correction, operative procedures more extensive than those originally needed and there is less chance of a cure. In a recent communication (1946)²² he stated that he is "now treating only very small hernias in young individuals or cases involving patients of advanced years who cannot tolerate surgery."

McKinney⁶ in 1937 made the following statement (*italics his*):

Too much emphasis has been placed on the injection solution and not enough on a proper fitting truss. The injection therapy has a place in the cure of hernia and instead of condemning it as quackery, surgeons should add it to their armamentarium in the treatment of hernia.

In a recent communication (1946)²² McKinney reaffirmed, with only slight modification, the view expressed in his article in 1937. He now states that, contrary to his previous experience, he believes that direct hernias are easier to cure than indirect ones and require fewer injections. He goes on to say that he is of the opinion that "the injection treatment plus the truss has a place in the therapy of hernia, but the over-emphasis on the solution and particularly the extravagant claims of the manufacturers has brought disrepute to the method."

On returning last year from five years of military duty, I sent out follow-up letters to 179 patients who had been given injections during the five year period of 1936 to 1940 inclusive. Only 38 (21 per cent) of the patients returned for observation. Of the 38 patients, 25 (66 per cent) were cured. All these were five to nine year cures. The hernias were of all sorts, direct and indirect, large (some scrotal) and small, in stout and thin persons, a great many of which were in elderly clinic patients among whom no attempt at selection had been made. All comers were being taken at the time the injections were made. Nearly all the patients who were not cured were greatly improved. None of the cured patients was wearing a truss. The cured and improved patients were all extremely grateful and highly

20. Archer, E. W.: *Hernia Injection*, M. Press 213:330, 1945.

21. McMillan, W. M.: Personal communication to the author.

22. McKinney, F. S.: Personal communication to the author.

satisfied with the treatment. One old man had had a scrotal hernia the size of an orange and had had his last injection eight years prior to the time of observation. He was completely cured and wore no truss, and I have never seen a more satisfied or appreciative patient. Cures of this type by the injection method, however, are unusual.

But what of the 141 patients (79 per cent) who did not return for observation? Undoubtedly a great many of these experienced unfavorable results and did not bother to return. One can only speculate on the number which came in this category. As most of the cases were observed in the clinic, probably a great many of the failures to return were due to indifference, irresponsibility or moving without leaving forwarding addresses. At any rate, an evaluation of this study gives no notion of the actual percentage of patients cured. It would seem fair to assume that there was a lower percentage of cures among those who did not return than among those who returned. Even if the percentage of cures among those who did not return was the same, it is even then still far below that for the operative method.

COMMENT

What conclusions, then, are to be drawn from the data at hand? I do not see how an unbiased arbiter can decide otherwise than that the operative treatment is a far superior method than the injection treatment as a curative procedure. Is there any place, then, for the injection treatment? My answer is in the affirmative. The following are the types of cases in which this method has a place.

A great many old persons not fit subjects for operation because of infirmities of old age have large hernias which cannot be retained satisfactorily by a truss and which cause them distress and inconvenience. The hernias frequently come out and are difficult to reduce and strangulation is often imminent. Many of the patients can be symptomatically cured by the injection method and kept so if they continue to wear a light truss, while recurrences ensue in a great many of them if the truss is discarded. Most of these old persons experience immediate relief after the injection treatment is started. The hernia no longer tends to slide out under the truss, and they begin to lead comfortable lives and are grateful for the relief that has been given them. A good example of this type of case was a 93 year old patient (referred to me by Dr. Harvey Stone) who had a scrotal hernia on the right side the size of a grapefruit and a nonscrotal hernia on the left side the size of a tangerine. There had been threatened strangulation several times on the right side, and the patient had been admitted to the hospital for operation when I was asked to see him. Since nothing could be lost by the use of the

injection method, it was tried, and a cure (symptomatic at least) was effected on each side. The patient died a year later from a stroke, and two months before death a small recurrence had developed on the right side. He had refused to continue to wear a truss after the injections were completed, otherwise it was felt that he would have remained cured.

There are a certain number of persons in industrial plants who have enlarged rings but not actual hernias and who are refused employment because of this. (A great many such persons were rejected for the army for the same reason.) These men are usually entirely unaware that anything is wrong with them until they apply for employment. The chances are that a great many of them would go through life without the development of a hernia. The compensation laws have made employers wary of accepting them as employees. This is not a scientific attitude, but it is at least an understandable one. In these cases it is possible to close the ring tight, to obliterate any suggestion of impulse that may be present, and to make the men entirely acceptable for employment. These patients do not want operation because they do not feel that there is anything wrong with them. Besides, operation is not desirable, as in some cases the operation may convert a potential hernia into a recurrent one.

There are some persons who will not, on account of fear or for other reasons, submit to operation. Others feel that they cannot take the time off for an operation, for either financial or business reasons. Some of these can be cured and others improved by injection. Even if the ones who cannot be cured have to continue to wear a truss, they are almost without exception much more comfortable after injection than they were before. The disagreeable sagging down feeling on coughing has disappeared, and they are no longer conscious of the fact that they have a hernia except for the fact that they are wearing a truss, which causes them little discomfort. A great many patients who found a truss almost intolerable before injection are comfortable in wearing it afterward. Also a great many are enabled to wear much lighter trusses after injection than it was necessary for them to wear before.

It is possible also that the method may have a place in the treatment of small hernias which have been operated on several times and persistently recur through a defect in the fascia. In such cases there is probably a better chance of satisfactory treatment by this method than by further operation. One patient of mine had been operated on three times on each side and each time by an exceptionally competent surgeon. He came to me after the third time.

and the recurrence on each side was through a defect in the fascia above the external ring, which was only 1 cm. in diameter. Both of these were treated by injection, and the patient has now been well for nine years.

CONCLUSIONS

1. The injection treatment of hernia has in no way replaced the operative method as the method of choice in treating hernia. Indeed, the extensive trial of the injection method during the past twenty years has placed the operative method in a firmer position than ever as the standard procedure in treating hernia.

2. A certain number of patients with hernia can be cured by the injection method. It is, however, at the present time impossible to determine just what percentage of cures can be obtained by it, even in properly selected cases.

3. The injection method has a place in the treatment of hernia, especially for patients coming in the following categories: (*a*) elderly persons unsuitable for operation due to the infirmities of old age; (*b*) persons rejected for industrial employment because of enlarged rings, with doubtfully demonstrable hernias; (*c*) patients who will not or cannot be operated on for personal reasons; (*d*) persons with certain types of recurrent hernia with small fascial defects.

4. It will be necessary for some of the patients in categories (*a*) and (*c*) to continue to wear trusses after the injection. This will depend on the size of the hernia and the build of the patient. Those who do have to continue to wear trusses are much more comfortable than they were before and can usually wear lighter trusses.

TREATMENT OF PERFORATION OF GASTROJEJUNAL ULCER BY RESECTION OF STOMACH AND ANASTOMOSIS

ALEXANDER LURJE, M.D.

MOSCOW, UNION OF SOVIET SOCIALIST REPUBLICS

THE TYPE of primary operation performed for gastrojejunal ulcer and the technic are undoubtedly of great importance. As shown by the data recorded by Beresov,¹ Sokolov,² Levin³ and Makkas,⁴ the gastrojejunal ulcer most frequently complicates anterior anastomosis after the method of Wolfer, less frequently resection for exclusion as performed by Finsterer, the posterior anastomosis and resection of the stomach according to Billroth's type II and most rarely resection of the stomach according to Billroth's type I.

The degree of physiologic and morphologic alterations in the stomach playing a decisive role in the pathogenesis of gastrojejunal ulcer is dependent not only on the type of operation but also on the character of the primary disease and on the technical deficiency of the first operation.

The tendency of peptic ulcers toward perforation and penetration is well known. Nevertheless, despite the great number of gastroentero-anastomoses performed during recent years, perforation of gastrojejunal ulcers is relatively rarely observed. Makkas in 1931 succeeded in collecting 170 cases from the literature. Levin believed that the total number of reported cases outnumbers 200. Forty of these cases were reported by Russian surgeons.

The following types of operations for perforation of gastrojejunal ulcers may be accepted: (1) suturing; (2) suturing and degastroentero-anastomosis; (3) resection of a portion of the small intestine with the ulcer, and (4) resection of the stomach and anastomosis.

From the Surgical Clinic of the Medical Institute, Molotov City (Director Professor, M. W. Shatz).

1. Beresov, E. I., and Ribinskiy, A. D.: *Bolesni operirovannogo jeludka i ich lechenie*, Gorky City, 1940.

2. Sokolov, S. E.: *Beiträge zur Frage des Ulcus pepticum jejuni post-operativum auf Grund eines Materials von 134 Fällen russischer Chirurgen*, Arch. f. klin. Chir. **149**:230-273, 1928.

3. Levin, M. M.: *Sabolewaniya jeludka operirovannogo po povodu jaswi*, Moscow, 1938.

4. Makkas, A. A.: *Die freie Perforation des postoperativen peptischen Jejunalgeschwürs*, Beitr. z. klin. Chir. **159**:61-84, 1934.

The statistical data of Makkas and of Toland and Thompson⁵ show that resection of the stomach and anastomosis give the best results. It may be assumed that this impression does not reflect the real state of affairs, since not all fatal cases are reported.

Up to 1934, a total of 24 resections of the stomach and anastomosis was performed for perforation of gastrojejunal ulcer, with 2 deaths (Makkas). Levin has reported 1 case, in which a favorable result was obtained. Two cases in which favorable results were obtained have been reported by Cellarius.

One case occurred in this clinic, which is of interest from the standpoint of pathologic anatomy.

A man aged 62 was admitted to the hospital on Oct. 18, 1941. Since 1933 the syndrome of duodenal ulcer had been present. In 1939 he had undergone an operation in one of the clinics in Kiev. After the operation his condition had been relatively satisfactory. On Oct. 17, 1941 (two years after the operation and ten hours before his admission) he had sudden severe pain in the abdomen with persistent vomiting. The pulse rate was 90. There was superficial breathing. The abdomen was swollen, and diffuse severe pain prevailed in the upper left half. There was disappearance of hepatic dulness. Blumberg's sign was present over the whole abdomen.

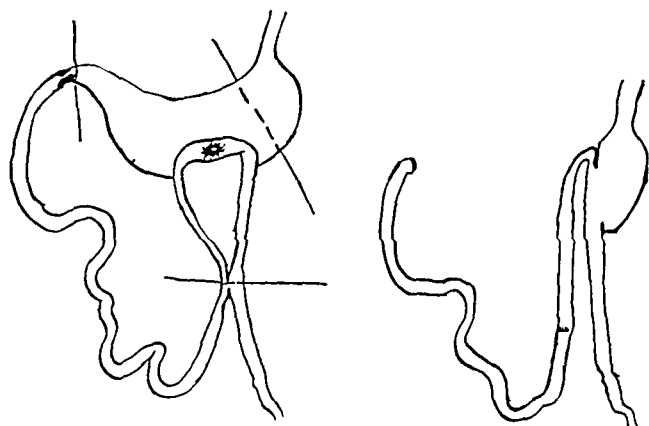
Laparotomy was performed for the syndrome of perforative peritonitis through a midline incision from the xiphoid process to the umbilicus. In the abdominal cavity there were gastroduodenal contents and turbid exudate. The incision of the abdominal wall was extended to the left from the upper angle, with transection of the sinew of the rectus abdominis. There was perforation of an area 4 mm. in diameter, on the anterior wall of the small intestine in the region of the anastomosis. The borders of the perforated area were fragile. The jejunal loop entering into the area of the anastomosis was found lying opposite to the peristalsis of the stomach in the middle region of the latter. Between the afferent and efferent jejunal limbs a Braun enteroanastomosis was disclosed. The dilated stomach had hypertrophied walls. In the initial portion of the duodenum a dense ulcerous scar obturated the lumen and prevented permeability. The possibility of suturing the ulcer's opening was excluded because of the fragility of its borders and the inevitability of subsequent additional deformation of the anastomosis. Resection of the distal two thirds of the stomach along with the afferent and efferent jejunal limbs was carried out, the inferior wall of the interintestinal Braun anastomosis being preserved. The small intestine and the duodenal stump were sutured. In the performance of the anastomosis after the method of Finsterer, it was disclosed that the transverse colon had an extremely short mesocolon. This inherent small sagittal mesocolon hampering the formation of the opening for the anastomosis caused the surgeon to prefer anterior anastomosis for the first operation in 1939. A sufficiently large opening was made in the mesocolon and it was separated anteriorly without disturbing the blood supply of the colon and the operation completed precisely according to the Polya-Finsterer method.

For the first four days after operation the patient was in a poor condition. The pulse rate was 100 to 110, and he had frequent vomiting. Transfusion of

5. Toland, C. G., and Thompson, N. L.: Acute Perforation of Gastrojejunal Ulcer, *Ann. Surg.* 107:827-852, 1936.

300 to 400 cc. of blood was carried out four times and lavage of the stomach three times. The wound healed with partial detachment of the ligatures. On Nov. 25, 1941, the patient was discharged in a satisfactory condition. Subsequent examination up to June 1942 showed recovery, increase in weight and good digestion. At the end of 1946 the patient, who had reached the age of 67, informed us that his condition had remained satisfactory.

Apparently the small size of the mesocolon and the resultant difficulty in exposure of the posterior gastric wall caused the surgeon to form the anterior anastomosis which was found far from the pylorus and deformed. The presence of the anterior anastomosis with the Braun enteroanastomosis created especially favorable conditions for the development and perforation of the gastrojejunal ulcer. If there had been no stenosing process in the initial portion of the duodenum, it would have been more rational to perform a degastroenteroanastomosis, with resection of only the deformed jejunal loop carrying the perforated gastro-



Resection of the stomach, with anastomosis.

jejunal ulcer, or to perform a degastroenteroanastomosis and suture the perforated area provided narrowing of the intestinal lumen could be avoided.

The whole pathologicoanatomic pattern called for an extension of the radical operation. It should be assumed that at the onset of peritonitis associated with perforation an extensive resection may be recommended only when no other operation can be performed successfully.

SUMMARY

In a patient aged 62 successful resection of the stomach and anastomosis were performed ten hours after perforation of a gastrojejunal ulcer. The development of the gastrojejunal ulcer was due to the fact that because of a short mesocolon an anterior gastroenteral anastomosis with Braun's enteroanastomosis had been performed for a duodenal ulcer two years previously.

USE OF HUMAN FIBRIN FOAM AND THROMBIN SOLUTION AS HEMOSTATIC AGENTS IN GENERAL SURGERY

DAVID STATE, M.D.

MINNEAPOLIS

HEMOSTASIS always presents a major problem to the surgeon. Where bleeding is brisk, as from a severed artery or large vein, it is usually stopped immediately by the application of forceps and ligatures. Much more difficult to control is the constant oozing that results from injury to small venules and capillaries. If one measures loss of blood by the increment of gain in dry sponges,¹ it becomes readily apparent that most of the loss of blood during the usual major surgical procedure is from the latter, rather than from the former, source of bleeding.

Bleeding from brain, kidney, liver or vascular tumors is difficult to control by the application of forceps or clips because of the friability of the tissues. In an operative field where infection is present or has subsided (as in decortication of a lung), the bleeding from the friable and tough fibrous tissue is most difficult to control, for hemostats and ligatures either tear out completely or cannot be applied.

Control of bleeding by packing with gauze in many instances has been a life-saving measure, but serious difficulties may be associated with the subsequent removal of the sponges. Often, the patient requires a general anesthesia as a means of combating the pain, and sometimes fatal hemorrhage follows the withdrawal of the packing.

Because of these problems, it is not surprising to note that surgeons turned to the use of clotting agents. In 1911, Cushing² used striated muscle as a hemostatic agent in neurosurgical procedures. He also suggested the possibility of obtaining fibrin from whipped blood and utilizing it instead of cotton gauze. This proposal resulted in the study by Grey,³ in 1915, of sheep's fibrin, which he believed more useful than

From the Department of Surgery, University of Minnesota Medical School.

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1. Wangensteen, O. H.: The Controlled Administration of Fluid to Surgical Patients, *Minnesota Med.* **25**:783-801, 1942.

2. Cushing, H.: Control of Bleeding in Operations for Brain Tumor, *Ann Surg.* **54**:1-19, 1911.

3. Grey, E. G.: Fibrin as an Haemostatic in Cerebral Surgery, *Surg., Gynec. & Obst.* **21**:452-454, 1915.

cotton sponges as a hemostatic agent and found relatively nonirritating in animal tissues.

In 1938, Seegers and co-workers⁴ were able to prepare a highly potent, purified, water-soluble thrombin obtained from beef plasma. They found this thrombin a valuable hemostatic agent in 225 cases.

Sponges made of a water-soluble gelatin base have been shown to be safe and effective hemostatic agents, both in the experimental animal and in man. The effectiveness of the sponge is apparently enhanced by the simultaneous use of thrombin solution. Microscopic studies of tissues in the rabbit into which portions of gelatin sponges had been inserted indicated that practically no foreign body reaction appeared about the inserted material, and the implants were completely absorbed in 30 dogs.⁵

Kenyon and associates⁶ showed that the conversion of cellulose (surgical cotton gauze) to an organic acid by the action of nitrogen dioxide rendered that material soluble at the alkalinity present in the tissue juices and absorbable by the body. Soluble cellulose was first employed by Putnam⁷ as a carrier for thrombin, but the recent observations of Seegers and Doub⁸ that thrombin is inactivated by the acidity of the oxidized cellulose invalidate his results. The acidity can be neutralized with 1 per cent sodium bicarbonate, making the oxidized cellulose an effective carrier of thrombin.⁹ However, the observations of Frantz and her co-workers indicated that oxidized cellulose is itself an effective hemostatic agent. They showed that it is readily absorbed and causes no appreciable foreign body reaction in the tissues, when used without thrombin solution.¹⁰

4. Seegers, W. H.; Smith, H. P.; Warner, E. D., and Brinkhous, K. M.: The Purification of Prothrombin, *J. Biol. Chem.* **123**:751-754, 1938.

5. Correll, J. T.; Prentice, H. R., and Wise, E. C.: Biological Investigation of a New Absorbable Sponge, *Surg., Gynec. & Obst.* **81**:585-589, 1945. Light, R. V., and Prentice, H. R.: Gelatin Sponge: Surgical Investigation of a New Matrix Used in Conjunction with Thrombin in Hemostasis, *Arch. Surg.* **51**:69-77 (Sept.) 1945.

6. Yockel, E. C., and Kenyon, W. O.: The Oxidation of Cellulose by Nitrogen Dioxide, *J. Am. Chem. Soc.* **64**:121-126, 1942. Unruh, C. C., and Kenyon, W. O.: Investigation of the Properties of Cellulose Oxidized by Nitrogen Dioxide, *ibid.* **64**:127-131, 1942.

7. Putnam, T. J.: The Use of Thrombin in Soluble Cellulose in Neurosurgery: Clinical Application, *Ann. Surg.* **118**:127-129, 1943.

8. Seegers, W. H., and Doub, L.: Oxidized Cellulose and Thrombin, *Proc. Soc. Exper. Biol. & Med.* **56**:72-73, 1944.

9. Uihlein, A.; Claggett, O. T., and Osterberg, A. E.: The Use of Oxidized Cellulose for Hemostasis in Surgical Procedures: Preliminary Report, *Proc. Staff Meet., Mayo Clin.* **20**:29-32, 1945.

10. Frantz, V. K.: Absorbable Cotton, Paper and Gauze (Oxidized Cellulose), *Ann. Surg.* **118**:116-126, 1943. Frantz, V. K.; Clarke, H. T., and Lattes, R.: Hemostasis with Absorbable Gauze, *ibid.* **120**:181-199, 1944. Frantz, V. K.: New Methods of Hemostasis, *S. Clin. North America* **25**:338-347, 1945.

Cohn and his co-workers,¹¹ in the department of physical chemistry at the Harvard Medical School, have in the course of large scale fractionation of human blood plasma made available purified portions of human fibrinogen and thrombin in large amounts.¹² From the fibrinogen, fibrin foam is made, and this with a solution of thrombin is used as an absorbable hemostatic agent.

Ingraham and Bailey¹³ recorded their experience with the utilization of fibrin foam and thrombin solution both in the experimental animal and in a wide variety of general and neurosurgical procedures. From their experimental studies, it appears that fibrin foam causes only minimal acute inflammatory reaction and is gradually absorbed in one to four weeks with such minimal fibrous tissue replacement that the location of the foam could not be identified one month after implantation. Observations in over 400 clinical cases indicated that in man the response to fibrin foam is similar to that observed in the experimental animal (chiefly monkeys).

MATERIAL AND METHODS

The fibrin foam and thrombin solution was supplied us by Drs. E. J. Cohn, O. T. Bailey and J. T. Edsall. The fibrin foam has a honeycombed structure, with nonuniform and varying degrees of porosity. It was forwarded in a sterile bottle, accompanied with a bottle of dry thrombin and a third bottle containing 30 cc. of sterile isotonic solution of sodium chloride, in a neat, compact package. When the agent is to be used, the saline solution is added to the dry thrombin; solution takes place readily. Pieces of fibrin foam, cut to the desired size, are soaked in the thrombin solution and are then ready for use in hemostasis. The fibrin foam, which is firm and somewhat brittle in the dry state, becomes rubbery and shrinks as fluid enters the air spaces. The fragments can be molded to conform to the shape of the surface and will retain the configuration after excess moisture has been removed.

11. Cohn, E. J.; Oncley, J. L.; Strong, L. E.; Hughes, W. L., and Armstrong, S. H., Jr.: *Chemical, Clinical and Immunological Studies on the Products of Human Plasma Fractionation: I. The Characterization of the Protein Fractions of Human Plasma*, *J. Clin. Investigation* **23**:412-432, 1944. Edsall, J. T.; Ferry, R. M., and Armstrong, S. H., Jr.: *Chemical, Clinical and Immunological Studies on the Products of Human Plasma Fractionation: XV. The Proteins Concerned in the Blood Coagulation Mechanism*, *ibid.* **23**:557-565, 1944.

12. Ingraham, F. D., and Bailey, O. T.: *The Use of Products Prepared from Human Thrombin in Neurosurgery: Fibrin Foam as Hemostatic Agents, Fibrin Films in Repair of Dural Defects and in Prevention of Meningocerebral Adhesions*, *J. Neurosurg.* **1**:23-29, 1944.

13. Ingraham and Bailey,¹² Bailey, O. T.; Ingraham, F. D.; Swenson, O.; Lowrey, J. T., and Bering, E. A., Jr.: *Human Fibrin Foam with Thrombin as Hemostatic Agent in General Surgery*, *Surgery* **18**:347-367, 1915.

If more fibrin is needed quickly, for some unforeseen emergency, it can be used after soaking in the thrombin solution for only one minute.

The value of fibrin foam is greatly enhanced by the fact that it can be left on the bleeding surface. As previously stated, the amount of tissue reaction after its use is minimal, and its absorption is rapid. Thus, the problems of pain and secondary hemorrhage that are associated with removal of cotton gauze packing are obviated.

OBSERVATIONS

At this clinic, my associates and I have used fibrin foam and thrombin solution as a hemostatic agent in a variety of situations (table). They have been used most frequently in controlling the ooze in the gallbladder fossa following cholecystectomy. Bleeding in this situation is always difficult to control by the usual means of clamping

Use of Fibrin Foam and Thrombin Solution as Effective Hemostatic Agents

Condition	Number of Cases
Cholecystectomy	12
Excision of metastases to liver.....	2
Traumatic laceration of liver.....	3
Resection of colon.....	3
Combined abdominoperineal resection of rectus.....	4
Carcinoma of stomach with extension to the pancreas.....	1
Pulmonary abscess.....	1
Sarcoma of posterior mediastinum.....	1
Subtotal thyroidectomy	4
Radical mastectomy.....	6
Curettage of actinomycotic infection of sinuses.....	1
Biopsy of sarcoma of the sacrum.....	1
Mediastinal adenoma of parathyroid.....	1
Epistaxis	1
Bleeding duodenal ulcer.....	1
Total.....	42

and ligating because of the friability of the liver substance. Fibrin foam soaked in thrombin solution was successful in controlling troublesome oozing in 12 cases.

On 5 occasions fibrin foam was used as a valuable adjuvant to the usual means of controlling bleeding from the liver substance. In 2 instances a wide resection of the liver was done for removal of metastases. The brisk arterial and venous bleeding was controlled by clamping and ligature, but the residual oozing, which was considerable, was controlled by the application of fibrin foam. In the other 3 cases, the liver substance was injured accidentally in surgical procedures directed toward the gallbladder and common bile duct. In each of these cases, hemostasis was effectively obtained with the use of fibrin foam and thrombin solution.

In resections of the right or left half of the colon, as well as in combined abdominoperineal resections of the rectum, large retroperitoneal spaces are uncovered. From these areas the bleeding is usually

from ruptured venules and capillaries and is considerable. It is in such cases that we have found fibrin foam and thrombin a valuable hemostatic agent.

This means of hemostasis has been used in 2 instances of resection of the right half of the colon, in 1 instance of resection of the left half of the colon and in 4 instances of abdominoperineal resection of the rectum, with an excellent result in each case. In an additional case, in which a carcinoma of the stomach involved the tail of the pancreas, the retroperitoneal oozing which followed resection of this portion of the pancreas was adequately controlled by the application of fibrin foam and thrombin solution.

On 2 occasions, hemostasis was obtained effectively with fibrin foam and thrombin solution in surgical procedures on the chest. In the first case, that of a pulmonary abscess, many vascular adhesions between the chest wall and the visceral pleura of the lung had to be cut in order to mobilize the lung for pneumonectomy. The considerable oozing from the surface of the lung and the chest wall was controlled with fibrin foam and thrombin solution. In the second case, in an attempt to remove a sarcoma from the posterior mediastinum, a considerable amount of venous bleeding from the surfaces of the tumor was encountered. Clamping and ligature of bleeding points were not possible because of the friability of the tumor tissue. Hemostasis was effected by application of fibrin foam soaked in thrombin solution to the surfaces of the tumor.

Control of bleeding from the residual stumps of thyroid tissue left after partial thyroidectomy always presents a difficulty, for clamping in this region is fraught with the possibility of damage to the recurrent laryngeal nerve. On four occasions bleeding from the remaining thyroid tissue was effectively controlled by the application of fibrin foam and thrombin solution.

After radical mastectomy, large surfaces of the chest wall show considerable oozing. In 6 instances, fibrin foam and thrombin solution was used, with excellent hemostasis and noticeable reduction of post-operative drainage from beneath the dissected skin flaps.

Curettage of sinuses or biopsy of tumor tissue is often followed by considerable hemorrhage, which is difficult to control by the usual means. In this study, in a case of actinomycosis of the cecum with sinuses through the anterior abdominal wall, considerable bleeding from one of the sinuses followed curettage. This bleeding was controlled by packing the depth of the sinus with fibrin soaked with thrombin. In the other case of operative intervention in this group, considerable bleeding followed removal of a biopsy specimen from an ulcerating sarcoma over the sacrum. Here, again, it was not possible to clamp the bleeding point because of the friability of the tissues. Packing with sterile cotton

gauze was considered, but experience with a similar case had indicated that considerable bleeding might occur after removal of the pack. On this occasion, hemostasis was effectively obtained by packing the bleeding area with human fibrin foam and thrombin solution.

The rest of the cases in which human fibrin foam and thrombin solution was used will be described in greater detail, for as a group they presented problems in hemostasis of greater proportions than those already discussed. In each instance, the use of human fibrin foam and thrombin effected hemostasis in a most gratifying fashion.

CASE 1.—Mrs. J. D., a white woman aged 54, was admitted to the hospital with a diagnosis of adenoma of the parathyroid gland. On June 4, 1943, she was operated on, and a large adenoma of the parathyroid gland (6 by 7 cm., weighing 24 Gm.) was observed in the superior mediastinum. After its enucleation from beneath the manubrium sterni, considerable bleeding occurred. Because of the diffuse nature of the hemorrhage and its inaccessible position, an attempt at control by clamping and ligating bleeding points was out of the question. Hemostasis, however, was obtained by packing the area from which the adenoma had been removed with fibrin foam soaked in thrombin solution.

CASE 2.—A white man aged 64 was admitted with a diagnosis of hypertensive vascular disease. The patient had an attack of epistaxis of severe proportions, which was controlled only temporarily by nasal packing and cauterization of the bleeding point with silver nitrate. It was then treated by applying a small pledget of fibrin foam soaked in thrombin solution to the bleeding point in the nasal septum, which could be readily visualized. After this application, the bleeding stopped and did not recur for approximately one week. At this time, a second bout of epistaxis was controlled by the application of fibrin foam soaked in thrombin to the bleeding point. After this, the patient had no more bleeding.

CASE 3.—C. D., a white man aged 64, was admitted to the hospital bleeding from a duodenal ulcer. He was treated with repeated blood transfusions and gastric suction. Although his blood pressure and pulse were adequately maintained, the hemorrhage continued, as evidenced by the bloody gastric contents on aspiration. Four units of thrombin dissolved in 80 cc. of isotonic solution of sodium chloride was introduced through the nasal tube and the suction discontinued for two hours. After this treatment no more blood appeared in the aspirated gastric contents. After an adequate period of preoperative preparation, the patient was subsequently subjected to subtotal gastric resection, without event.

COMMENT

From the work of Ingraham and Bailey,¹² human fibrin foam appears to cause only slight acute inflammatory reaction and is gradually absorbed, with minimal fibrous tissue replacement. The circumstance that in the cases just reviewed wound healing was uneventful and the postoperative clinical picture showed no evidences of unusual elevation of temperature or of the pulse or respiratory rate is confirmative of the observations of Ingraham and Bailey that the hemostatic agents used are well tolerated by the tissues.

In 1 of these cases, it was necessary to reexplore the common bile duct approximately two months after a cholecystectomy, in which

human fibrin foam and thrombin had been used to control bleeding from the gallbladder fossa. No discernible residual portion of the fibrin foam was seen. Although fibrous adhesions were present, they were no more numerous or extensive than those usually encountered on reexploring the area of the common bile duct after a previous cholecystectomy.

In the 1 case of bleeding duodenal ulcer previously described, bleeding ceased coincidentally with the administration of thrombin solution through the nasal tube. Subsequent operation revealed a chronic duodenal ulcer on the anterior wall. It is difficult to believe that the thrombin solution could have caused hemostasis if the bleeding had come from the gastroduodenal artery. Recently, however, I have observed several cases of erosive gastritis in which multiple minute, superficial ulcers are present and from which considerable bleeding may occur. It seems reasonable to expect that thrombin solution can act as a hemostatic agent more readily when the bleeding is from minute erosions than when it is from large vessels. How frequently erosive gastritis is the cause of bleeding, even in the presence of a known chronic duodenal or gastric ulcer, is not known. Thrombin is inactivated by acids; hence, one would not expect this agent to be effective in the presence of gastric juices. However, blood in the stomach may have sufficient buffering capacity to prevent the inactivation of the thrombin. Thus, it would seem that the use of human thrombin solution in the presence of bleeding from the stomach or duodenum is a worth while procedure.

SUMMARY

Fibrin foam and thrombin solution has been used in 42 cases of varied types, with uniformly good hemostasis. It has been of particular value in controlling bleeding from the gallbladder fossa, liver substance and retroperitoneal tissue spaces.

From the clinical picture, in the cases in which it has been used, fibrin foam appears to be well tolerated by the tissues. Because the fibrin foam can be left within the tissue, it is a valuable hemostatic agent where packing is practically the only means of controlling hemorrhage, i. e., in bleeding following enucleation of a retrosternal tumor, removal of biopsy specimens of friable vascular tumors and curettage of sinuses with actinomycotic infection.

In a patient with a bleeding duodenal ulcer, the cessation of hemorrhage coincidental with the administration of human thrombin into the stomach through a nasal tube suggests that the hemostatic agent should be given further trial in cases of actively bleeding duodenal or gastric ulcer.

Use of fibrin foam and thrombin solution is a valuable addition to methods of hemostasis already available to the surgeon.

University of Minnesota Medical School.

FOLLOW-UP RESULTS OF SURGICAL TREATMENT FOR NONUNION OF THE CARPAL SCAPHOID BONE

Report of Nineteen Cases

C. FRED GOERINGER, M.D.*

Instructor in Orthopedic Surgery, University of Pennsylvania School of Medicine
PHILADELPHIA

THE LITERATURE on fractures of the carpal bones of the wrist is voluminous. Confusion exists particularly in regard to treatment of nonunion of the carpal scaphoid. I have had experience in evaluating the results of acute injuries to the hand of soldiers in training and in combat and also in the evaluation of chronic wrist complaints of inductees. Many of the latter had been under the care of both civilian and military physicians and were treated for so-called sprain of the wrist.

A total of twenty operations has been performed on a series of 19 patients who had nonunion of the carpal scaphoid. The procedure used in 16 patients was originally described by Gordon Murray.¹ A bone graft taken from the tibia was employed. Successful bony union occurred in every instance but 1 (case 3, retroulnar dislocation of the capitate). In 8 of the 16 cases supplementary drilling was done during the bone-pegging procedure. Follow-up studies indicate that surgical treatment is attended by sufficient success to warrant the use of a bone graft procedure in well selected cases.

In order to evaluate the problem of nonunion, knowledge of the physiologic function of the carpal scaphoid bone and an understanding of its anatomic relationships are desirable.

ETIOLOGIC FACTORS

Most injuries of the scaphoid are caused by indirect violence such as a fall on an outstretched hand. The bone acts as a buffer between the distal carpus and the radius. In most cases the force of the fall is indirectly transmitted to the capitate and then to the scaphoid through the third metacarpal bone. The severity of compression of the scaphoid depends on the degree of radial or ulnar deviation at the time of the impact.

* Formerly Lieutenant Colonel, Medical Reserve, United States Army.

1. Murray, G.: Bone Graft for Non-Union of Carpal Scaphoid, *Brit. J. Surg.* 22:63-68 (July) 1934; *Surg., Gynec. & Obst.* 60:529-530 (Feb.) 1935.

DIAGNOSIS

The history of a fall on the outstretched hand, tenderness on the ventral surface over the scaphoid or in the anatomic snuffbox and pain at these points on percussion of the extended thumb strongly suggest a lesion of the scaphoid bone. Roentgenograms taken at the proper angle may give conclusive evidence of fracture. Occasionally the central beam of the roentgen ray fails to coincide with the plane of the fracture. Satisfactory views may be taken with the fist clenched and the fingers resting on the x-ray plate with the palm down in extreme ulnar deviation and pronation. Soto-Hall² advocated the "praying position" of the hands for the lateral view. When the roentgenograms fail to show the fracture, one must rely on the clinical findings as presumptive evidence of fracture. Immobilization of the wrist for three weeks may be resorted to. After this, should roentgenologic studies again not reveal fracture the patient's ligamentous injury will have been helped by rest. At least two oblique views are needed to complete the study, with the palmar and dorsal surfaces of the wrist alternately next to the plate.

DIFFERENTIAL DIAGNOSIS

Bipartite scaphoid is rare, but it may be confused with fracture; either of the two distal corners may be separate or cartilaginous, or there may be a separation at the waist. Developmentally, there are two centers of ossification instead of the usual one for each carpal bone. Bunnell³ has indicated the following points in the differential diagnosis: the presence of the same abnormality in the other wrist, the absence of a history or of signs of injury and the rounded, clearcut edges with equal bone density of each part as shown in the roentgenogram. This differs from fracture because of the irregular margins and the patchiness or increased density of lime in the proximal fragment.

Thomas Dwight⁴ stated that in bipartite scaphoids the line of division runs obliquely from near the outer end of the articular surface of the radius to about the middle of the concavity of the head of the capitate. When an unusual roentgenographic appearance of the carpal scaphoid is observed, one must consider developmental variations. Roentgenograms of the opposite wrist should be taken.

2. Soto-Hall, R., and Haldeman, K. O.: Treatment of Fractures of Carpal Scaphoid, *J. Bone & Joint Surg.* **16**:822-828 (Oct.) 1934. Soto-Hall, and others: Fractures of the Carpal Scaphoid, *J. A. M. A.* **129**:335-338 (Sept. 29) 1945.

3. Bunnell, S.: *Surgery of the Hand*, Philadelphia, J. B. Lippincott Company, 1944.

4. Dwight, T.: *Variations of the Bones of the Hands and Feet*, Philadelphia, J. B. Lippincott Company, 1907.

INCIDENCE

The fracture most commonly occurs in the male sex principally because of the fact that there is a greater participation in industry and in athletic events which expose to trauma. The right wrist seems to be involved a little more commonly than the left. The fact that most persons are right handed may be a contributing factor.

Thorndike⁵ noted that in 11 (65 per cent) of a series of 17 cases involving college students there were old or previously unrecognized fractures. The incidence was about four times that of Colles' fractures in the age group between 16 and 25 years of age. Zwerg and Heideman⁶ reported that 1.3 per cent of all fractures occur in the scaphoid. In the annual report from the Surgeon General of the United States Navy for the years 1933 to 1936 inclusive 2.2 per cent of the 6,544 fractures of all bones were said to be fractures of the scaphoid. In studying 100 such fractures, Burnett⁷ found that only 6 per cent occurred in females. Forty-eight per cent of his patients were 20 years of age or under.

Böhler⁸ mentioned that Schenk collected all the cases in their hospital over a six year period and found that there were 437 cases of carpal injuries. During the same time there were 669 cases of fractures and separation of the epiphysis of the lower end of the radius.

Cutler⁹ estimated that failure of union occurs in 30 to 40 per cent of all cases of fractures of the carpal scaphoid. Compere and Banks¹⁰ recognized aseptic necrosis of the carpal scaphoid to be second in frequency only to aseptic necrosis of the head of the femur. They stated that fractures through the waist of the carpal scaphoid result in necrosis of the proximal fragment in about one third of all cases.

CLINICAL FINDINGS

In the fresh cases there is some localized swelling over the carpal region. This is always distal to a line drawn between the styloid processes. There is soft edema in the region of the anatomic snuffbox but no ecchymosis as is frequently seen in other fractures. Pressure in the snuffbox causes some discomfort. Motions in the wrist joint are limited and painful, especially those of dorsal flexion and radial flexion. Hand grip is usually impaired.

5. Thorndike, A., Jr., and Garrey, W. E.: Fractures of the Carpal Scaphoid, *New England J. Med.* **222**:827-830 (May 16) 1940.

6. Zwerg and Heideman, cited by Hook.¹⁵

7. Burnett, J. H.: Fractures of the (Navicular) Carpal Scaphoid, *Surg., Gynec. & Obst.* **60**:529-530 (Feb.) 1935.

8. Böhler, L.: *The Treatment of Fractures*, ed. 4, Baltimore, William Wood & Company, 1935.

9. Cutler, C. W.: *The Hand: Its Disabilities and Diseases*, Philadelphia, W. B. Saunders Company, 1942.

10. Compere and Banks, cited by Waugh and Reuling.²³

PROGNOSIS

Any fracture untreated or improperly treated for as long as three weeks should be considered as a neglected fracture, and the chances of getting primary union by immobilization are not so good as one would expect to obtain with earlier immobilization.

Thorndike and Garrey⁵ indicated that in their experience the disability in cases of nonunion is rather insignificant and often negligible. This is the case even for periods of up to five years after the fracture. They advised that only patients with definite disability should be urged to have the open operation of bone pegging or drilling. Cravener and McElroy¹¹ obtained good results in 14 of 15 carpal scaphoid fractures with the bone peg procedure. They stated that if one wanted to be absolutely certain of the result in the treatment of waist fractures, even those less than a week old, fragments should be joined by a bone graft. For ancient ununited fractures associated with a degenerative arthritis, these authors advocate removal of the proximal fragment. They are also of the opinion that in cases in which the degenerative type of arthritis has already set in no bone grafting or drilling will restore the wrist to normal.

Böhler⁸ stated that he has never observed a case in which the usefulness of the hand has returned to normal after the removal of the carpal scaphoid. After the bone has been removed the hand inclines to the radial side and the hand grip is weakened.

Kemper¹² has collected over 60 instances of removal of the scaphoid and lunate bones. In all of them the function of the hand was poor.

Hirsch¹³ reported excellent results in 9 cases after total removal, with perfect return of function of the wrist and with no trace of radial deviation of the hand.

PATHOLOGIC PROCESS

Armstrong¹⁴ has indicated that three factors may contribute to nonunion of the carpal scaphoid. In the first place, the structure of the bone is cancellous and there is no true periosteum. Hence new bone formation is slow. In the second place, the fracture impairs the blood supply to the fragments. A third factor may be inadequate treatment which allows movement to take place between the fractured surfaces.

11. Cravener, E. K., and McElroy, D. G.: Fractures of the Carpal (Navicular) Scaphoid, *Am. J. Surg.* **44**:100-106 (April) 1939.

12. Kemper, cited by Böhler.⁸

13. Hirsch, M.: Konservative oder operative Therapie der Fraktur des Os navicular carpi? *Wein. med. Wchnschr.* **85**:803-804 (July 13, 1935): comment by Böhler: *ibid.* **85**:1085 (Sept. 28) 1935; reply by Hirsch: *ibid.* **85**:1086 (Sept. 28) 1935.

14. Armstrong, J. R.: Closed Technique for Fixation of Fractured Carpal Scaphoid, *Lancet* **1**:537-540 (April 26) 1941.

Hook¹⁵ has shown that motion in the proximal row of the carpus requires more extensive cartilaginous surfaces for articulation with the radius than that in the distal row. This proportionately large joint or cartilaginous surface reduces the area for ligamentous and capsular attachment, thereby lessening the area in which the blood supply may reach the bone. This is especially true of the scaphoid, where the blood supply, which consists of small terminal twigs, enters the bone through the fibers of the collateral radial ligament. In the study of 297 carpal scaphoids removed from cadavers, Oblatz and Halbshtein¹⁶ found that in 13 per cent there were no arterial foramina proximal to the constricted midportion or "waist" of the bone. In 20 per cent there was a single small arterial foramen at the waist or proximal to it, and in 67 per cent there were two or more foramina proximal to it. Since most scaphoid fractures occur through the waist of the bone, this finding may be of importance in the development of nonunion.

When the carpal scaphoid is injured, some crushing in the spongiosa, with damage to the blood supply, occurs. The nutrient vessels which enter through the periosteum, the nutrient foramina and the ligamentous attachments may be torn off. Absorption of bone takes place at the fracture line, and an intervening space may be visible roentgenologically. When immobilization is inadequate, the absorption process continues. A cystlike formation in the nonviable fragment sometimes occurs (fig. 5A). A slow aseptic necrosis develops over a period of many weeks. Since the blood supply is impaired, there is little or no attempt at repair. Scarring and irritation in the synovia and bones of the wrist occur, with resulting osteoarthritis deformans.

Fractures throughout the tubercle, which is vascular and extra-articular, unite whether splinted or not.

Occasionally there is comminution, with more or less displacement. The injury may be associated with dislocation of the semilunar bone (case 3). Complicating fractures of the radius and ulna may occur.

PHYSIOLOGIC PROCESS

MacConaill¹⁷ pointed out that the carpal scaphoid moves with the proximal carpal row in the earlier stage of dorsiflexion and with the distal row in the later stage. Conversely, the scaphoid moves with the distal row in the earlier stage of volar flexion and with the proximal row in the later stage. In the course of the movement from full volar flexion

15. Hook, F. R.: Fractures of the Carpus, U. S. Nav. M. Bull. **37**:553-566 (Oct.) 1939.

16. Oblatz, B. E., and Halbshtein, B. M.: Non-Union of Fractures of Carpal Navicular, J. Bone & Joint Surg., **20**:424-428 (July) 1928.

17. MacConaill, M. A.: Mechanical Anatomy of the Carpus and Its Bearing on Some Surgical Problems, J. Anat. **75**:166-175 (Jan.) 1941.

to full dorsal flexion movement of the capitate on the scaphoid occurs up to the position of extension; thereafter these bones are at rest on each other but move together on the lunate until full dorsiflexion has been attained. Conversely, in the movement from dorsiflexion to full volar flexion the capitate and scaphoid move on the lunate during extension of the hand; thereafter the capitate moves on the lunate and the scaphoid, which are, in turn, immobile. The dynamic relations of the scaphoid in various carpal positions provide the key to the mechanism of the severity and type of the injury. The side to side pressures of the bones against each other are just as important functionally as the longitudinal pressures.

TREATMENT

Fractures of the carpal bones, particularly the scaphoid, treated within a few days of injury unite in a high percentage of cases if immobilization is effective. Roentgenologic evidence of union can be expected in from eight to twelve weeks. Bony or fibrous union may result nevertheless from immobilization alone, if it is maintained for periods ranging from four to eighteen months. In civilian life, such treatment may be compatible with a comparatively normal existence on the part of the patient, but in the services, under wartime conditions, immobilization of one wrist in plaster renders a man noneffective. Any form of treatment which may cut down the period of immobilization necessary to obtain bony union is worth while. The factors seem to indicate that the ideal method of treatment would be a combination of external and internal fixation, preferably by the use of an autogenous bone peg. The introduction of a bone peg across the bony fragments should hasten bony union.

Armstrong¹⁴ stated that the technics of bone grafting are open to grave objections. This is particularly so when considerable stripping of the scaphoid, with consequent disturbance of its blood supply, is carried out. To overcome these disadvantages he has developed a closed operative technic whereby the peg can be introduced through a small incision in the skin under roentgenologic control, without any exposure or stripping of the fragments of the scaphoid.

Edelstein¹⁸ advocated the proper positioning in a cast which holds the wrist in dorsiflexion and radial deviation. This position approximates the radial styloid and the lesser multangular against the outer fragment of the fracture and compresses the latter against the inner fragment, which is jammed up against the capitate.

Böhler⁸ disapproved of the removal of the scaphoid for nonunion and quoted Kemper, who reported a series of 60 cases in which removal of the scaphoid resulted in poor function of the hand.

18. Edelstein, J. M.: Treatment of Ununited Fractures of the Carpal Navicular, *J. Bone & Joint Surg.* **21**:902-908 (Oct.) 1939.

A method of treatment which consists in filling both fragments and the space between them with fresh living cancellous bone taken from the greater trochanter has been described by Matti¹⁹ (from Hook¹⁵). The fragments are hollowed out with a sharp curet, and the cavity is packed with cancellous bone. Satisfactory results in 3 patients treated in this manner were reported. Kellogg Speed²⁰ (from Hook¹⁵) expressed the belief that a fusion of the diseased fragments to the healthy neighboring carpus is preferable to excision. Hook found that proper treatment of recent fractures of the scaphoid results in a high percentage of cures (75 to 100 per cent).

Bunnell³ favored excision in all cases of sequestration of the proximal fragment of the scaphoid in order to prevent osteoarthritis. The sharp edges of the distal fragment are rounded off where they articulate with the radius.

OPERATIONS

Meekison²¹ recognized the following procedures:

1. Immobilization from four to six months if necessary, depending on roentgenographic evidence of union. This treatment is reserved for fractures which are not too old, that is, of one to three months' duration, and in which accurate reduction can be obtained.

2. Excision. This applies to the proximal fragment, when it is the smaller of the two and shows evidence of aseptic necrosis. Excision is not advocated in cases of waist fractures. It is undertaken before arthritic changes take place in the wrist joint.

3. Bone graft. The simple dorsal approach using a peg or inlay graft is the safest.

4. Arthodesis of the wrist. This procedure offers freedom from pain and a strong wrist. However, dorsiflexion and volar flexion are lost but supination and pronation are preserved.

Milgram²² (cited by Meekison²¹) described a method of denuding the dorsal aspect of both fragments, by which they are hollowed, particularly the proximal one, and the continuous cavities so created filled with cancellous bone. This bone is obtained beneath the crest of the ilium. This procedure has been used in 10 cases, in 9 of which union has occurred with a bony bridge across the gap. In 1 aseptic necrosis of the proximal fragment has persisted. Milgram pointed out the fact that all fractures of the carpal scaphoid bone do not merit intervention. He has seen asymptomatic nonunion of the carpal scaphoid persist with-

19. Matti, cited by Hook.¹⁵

20. Speed, cited by Hook.¹⁵

21. Meekison, D. M.: Some Remarks on Three Common Fractures of the Carpal Scaphoid, *J. Bone & Joint Surg.* **27**:80-85 (Jan.) 1945.

22. Milgram, cited by Meekison.²¹

Results of Treatment for Nonunion of the Carpal Scaphoid Bone

Case	Age	Conservative Treatment	Time Interval Between Fracture and Operation	Time of Letter Follow-Up Since Operation	Pain	Latest Clinical Picture		Hand Grip	Rating of Result*	Comment
						Flexion Limited	Extension Limited			
1	10	Early strapping, late splinting	14 mo.	27 mo.	Slight, occasionally on lifting	No	No	Good	Excellent	Boxing injury—wrist fracture
2	32	Early strapping	4 mo.	5 yr.	Occasionally in wet weather	10%	10%	Good	Excellent	Fall—left wrist; distal fragment white; patient given medical discharge because of diabetes; salesman
3	21	Immediate cast, but retrolunar dislocation of capitate was unreduced for 2 wk.	1st operation 2 weeks; reduction, drilling and curettage of fragments; 2nd operation 4 months; bone pegging	2 yr.	Frequent	35%	35%	Poor	Poor; non-union 3 years later	Diving accident—left wrist; proximal fragment white; arthritis in radiocarpal joint
4	22	Late cast, worn 9 wk.	6 mo.; fragments drilled and curetted	5 ⁵ / ₁₂ yr.	On lifting	25%	35%	Fair	Fair	Fall—left wrist; distal fragment white; arthritis; bartender
5	28	No treatment	4 mo.	6 mo.	Occasionally	10%	10%	Good	Good	Fall—right wrist; proximal fragment white; overseas service
6	23	No treatment	10 mo.	4 ⁵ / ₁₂ yr.	Occasionally	15%	15%	Good	Good	Fall—right wrist; distal fragment white; overseas service
7	23	Late strapping	5 yr.	2 ⁹ / ₁₂ yr.	Slight	10%	10%	Excellent	Excellent	Jerk injury—right proximal ¹ / ₄ of bone; roentgenogram in 1943 showed solid union
8	22	No treatment	1 yr.; fragments drilled and pegged	1 yr.	No	10%	10%	Good	Excellent	Fall—left wrist
9	29	Cast 11 wk., late	10 mo.	4 yr.	Slight, occasionally	No	No	Excellent	Excellent	Lifting—left wrist; proximal fragment white; prize fighter

10	20 (Negro)	.....	3 yr.; fragments curetted and drilled 4 mo.	1 yr.	No	No	No	Excel- lent	Excel- lent	Fall—right waist; proximal frag- ment white
11	22	Early cast		4 yr.	No	No	No	Excel- lent	Excel- lent	Fall—left waist; complicated by acute hemorrhagic pancreatitis; postal clerk
12	30	No early treatment; roentgenogram in 1933 showed frac- ture; subsequent casts on 5 occa- sions	9 yr.; fragments drilled and pegged; rough surfaces	1 yr.	No	15%	15%	Excel- lent	Excel- lent	Fall—right waist
13	24	Early strapping 1937	5 yr.; drilling and bone pegging	4 yr.	Slight	15%	15%	Excel- lent	Excel- lent	Fall—left waist; distal fragments white
14	22	Late casts	6 mo.	3½ yr.	No	20%	20%	Good	Good	Fall—right waist; proximal frag- ment white
15	25	Late casts 6 months	3 mo.	9 mo.	No	15%	15%	Excel- lent	Excel- lent	Fall—right waist
16	27	.....	8 mo.	1 yr.	Occasional, on lifting	No	No	Good	Good	Fall—waist
17	29	1934—no cast treat- ment	8 yr.; fragile white proximal fragment removed; poorly approximated	4 yr.	Yes	20%	30%	Fair	Fair	Boxing—left waist; arthritis; prox- imal fragment white; overseas service
18	20	No treatment	3 mo.; fragments separated and eburnated; looked antique; distal fragment removed	1½ yr.	Slight	15%	20%	Good	Good	Fall—right waist; distal fragment white; overseas service
19	26	Late splinting	2 mo.; retrolunar dislocation of capitate reduced 2 mo. later; proximal scaphoid and lunate removed; arthrodesis to be done later	1 mo.	Yes	Wrist and finger limita- tion	50%	Poor	Poor	Fall—right waist, complicated by a median palsy (distal) and limited finger motion

* End results listed in the table were based on the following criteria: excellent—not more than 15 degrees of limitation of palmar flexion or dorsiflexion, pain more than 25 degrees in either palmar flexion or dorsiflexion; fair—pain on prolonged use of the wrist when working; hand grip good and motion limited by not on slightest exertion, considerable limitation of motion, weak hand grip and roentgenologic evidence that the bone is not healed or evidence of arthritis. An additional patient has been treated since this table was prepared. The bone graft consisted of the cortex taken from the ulna. There was sound bony union of the waist fracture. The end result is excellent after one year.

out arthritis, and in another case of nonunion he has observed apparent union occur years later spontaneously.

Waugh and Reuling²³ have added another method of treatment, which consists of replacement of the scaphoid which has been excised by means of vitallium® prosthesis.^{23a} This operation is indicated in (1) fresh fractures with the fragments badly comminuted and displaced, particularly those involving the proximal portion, (2) old cases of pseudarthrosis in which the site of fracture is through either the waist or the proximal portion and associated with local deforming arthritis and (3) cases of reinjury in which the clinical symptoms and the disability persist after an adequate period of immobilization.

STUDY OF CASES

In every instance but one the fracture of the scaphoid was through the waist. In this case the fracture line was at the junction of the proximal and distal thirds of the scaphoid. All the patients operated on were between the ages of 20 and 31. The longest history of known fracture of the scaphoid, verified originally by roentgenologic study, was approximately eight years. During this interval the patient wore a cast on six occasions for varying periods, but nonunion resulted. After the bone peg operation, complete union occurred and the end result was excellent. In no instance in this series was operation performed for an acute fracture. Immobilization was used for at least four months, at the end of which time a bone graft procedure was performed if nonunion persisted. In 4 of the 16 cases there had been existing disability for at least three years prior to operation. The left wrist was involved in 9 cases and the right in 7 cases. After operation the average duration of immobilization in a cast was sixteen weeks. In each instance a tibial bone graft was removed from the anterior crest of the upper part of the tibia. Splinting of the leg for three weeks was accomplished with a posterior plaster splint. The patient was allowed up on crutches, and gradual weight bearing was instituted. When the tibia on the contralateral side is used as the graft donor site, walking with crutches is facilitated. The only postoperative complication in this series occurred in case 11, in which a postoperative acute recurrent pancreatitis developed which necessitated an exploratory laparotomy. Five of the 16 patients have a complete range of motion, and in follow-up letters they state that the hand which was operated on is just as good as the other one. Eight patients have slight pain which is noticeable when it is necessary to exert the wrist a great deal, as in lifting.

23. Waugh, R. L., and Reuling, L.: Ununited Fractures of the Carpal Scaphoid, *Am. J. Surg.* **67**:184-200 (Feb.) 1945.

23a. Vitallium contains cobalt, chromium and molybdenum.

Only 1 of the 16 patients was separated from the service, and this was for diabetes mellitus (case 2). This disease had no effects on bone union, and the end result was excellent.

Case 3 was one of traumatic fracture of the waist of the scaphoid and retroulnar dislocation of the capitate of two weeks' duration. A closed reduction was attempted using Kirchner wire fixation in the metacarpals and a Roger-Anderson dual half pin unit through the olecranon. Gradual traction on the anatomic splint applied under fluoroscopic guidance was unsuccessful (fig. 2). One week later an open reduction was performed, at which time the fracture dislocation was adequately reduced. The triquetrum was removed, and the surfaces of the scaphoid fragments were curetted. Kirschner wire drills were

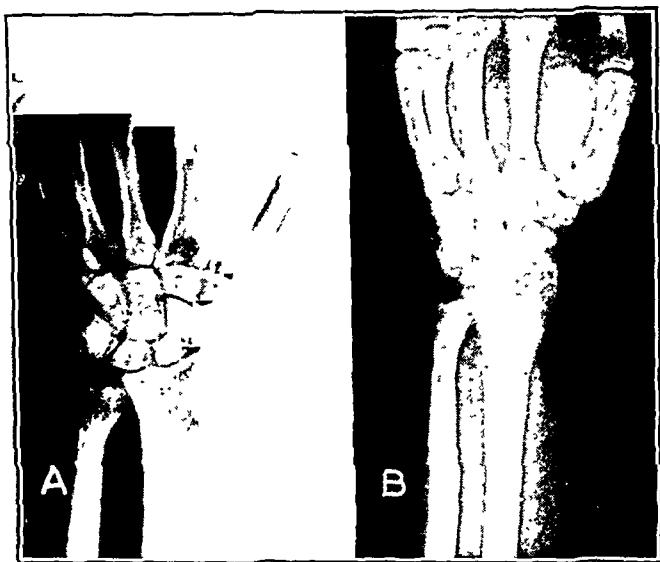


Fig. 1 (case 1).—Preoperative (A) and nine month postoperative (B) roentgenograms indicating bony union. End result excellent.

inserted across the fracture line several times. Roentgenograms taken four months later revealed nonunion of the scaphoid. Open reduction was again performed. The proximal fragment appeared to be whiter than the distal one. A tibial peg graft was placed across the fracture line, and once again the fragments were drilled. The cast remained in place approximately four months postoperatively. Roentgenologic studies three years later indicated that scaphoid union had not occurred. The total period of immobilization from the time of injury was about nine months. The end result is rated as poor in this case since the patient continued to have pain, tenderness, limitation of motion, weak hand grip and inability to use the hand in the work required of him. These symptoms were due to fibrosis, arthritis and nonunion. This case was the only one in the series in which bony union was not obtained.

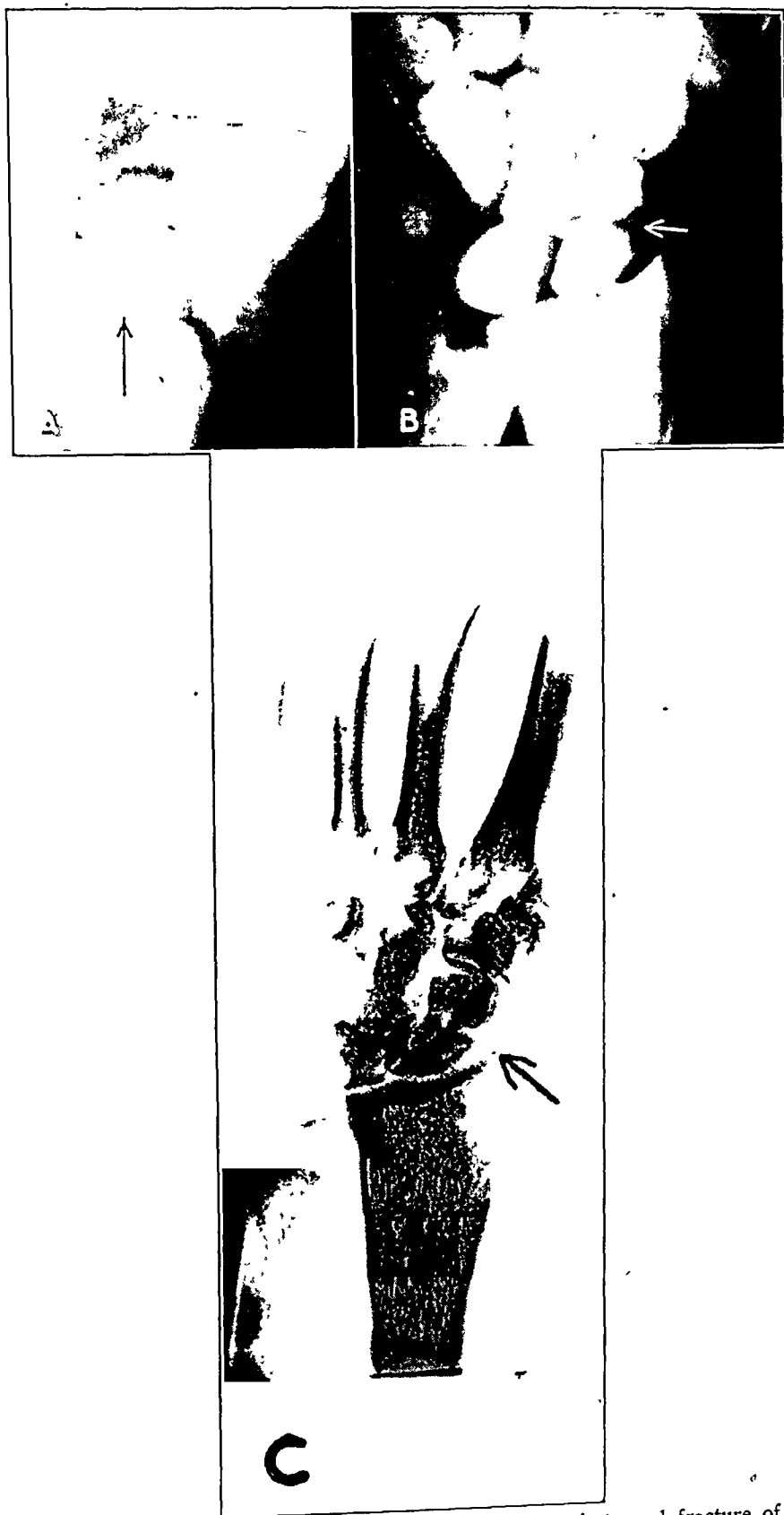


Fig. 2 (case 3).—*A*, retroulnar dislocation of the capitate and fracture of the scaphoid bone, lateral view. *B*, anteroposterior view showing fracture dislocation. *C*, immediate postoperative roentgenograms taken on March 12, 1941. The original open reduction was performed three months earlier, at which time the fragment were drilled. Nonunion occurred, and subsequent arthritic changes developed. The result was poor.

Conservative early treatment was successful in another soldier who sustained a retroradial dislocation of the capitate and concomitant fracture of the waist of the scaphoid (fig. 3 *A* and *B*). A closed reduction was successfully carried out on the day of injury under general anesthesia. Union of the fracture has occurred. A follow-up letter written several months later stated that the patient had a good range of motion and the only complaint was slight weakness of the hand grip and pain in wet weather. Two instances were observed in which necrosis developed in the scaphoid. In 1 case the distal (case 18) and in the other the proximal fragment (case 17) was involved. Both of the patients have continued to have disability despite excision of the affected fragment.

OPERATION

With the hand held in full adduction and pronation, incision is made over the "snuffbox" just lateral to the extensor pollicis longus tendon

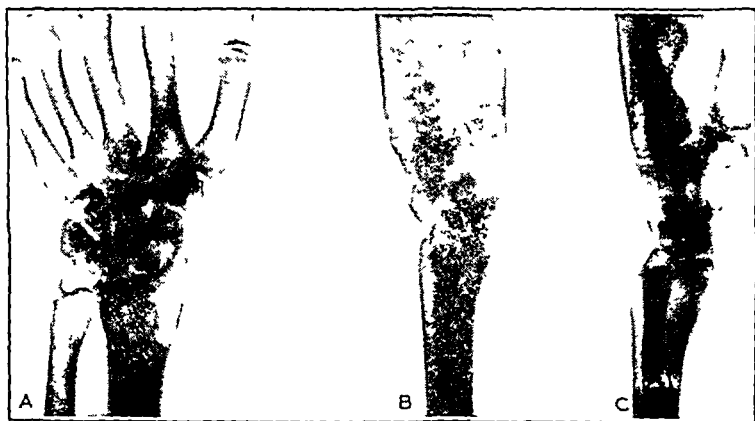


Fig. 3—*A* and *B*, retroradial dislocation of the capitate and fracture of the carpal scaphoid. Treated early by closed method. Excellent result, clinically and roentgenologically. *C*, postoperative reduction.

down to the deep fascia. The superficial branches of the radial nerve and the abductor and extensor thumb tendons are identified and suitably retracted. The short extensor, the long abductor of the thumb and the extensor indicis proprius are retracted to the radial side and the long extensors to the ulnar side of the incision. It has been found convenient to use two small self-retaining mastoid retractors, one at each pole of the wound. The dorsal carpal ligament is incised, and a transverse incision is then made in the capsule which can be seen in the depth of the wound. Periosteal elevation is then accomplished over the lower end of the radius for a distance of about 1 cm. This allows a more satisfactory exposure of the joint, and subsequent closure is also facilitated. A minimum of dissection is essential over the scaphoid proper. Identification of the fracture is facilitated by having an assistant place

traction on the thumb, which draws the surfaces of the wrist joints apart. A "spud" is then inserted between the articular surface of the radius and the scaphoid. This allows excellent visualization of the

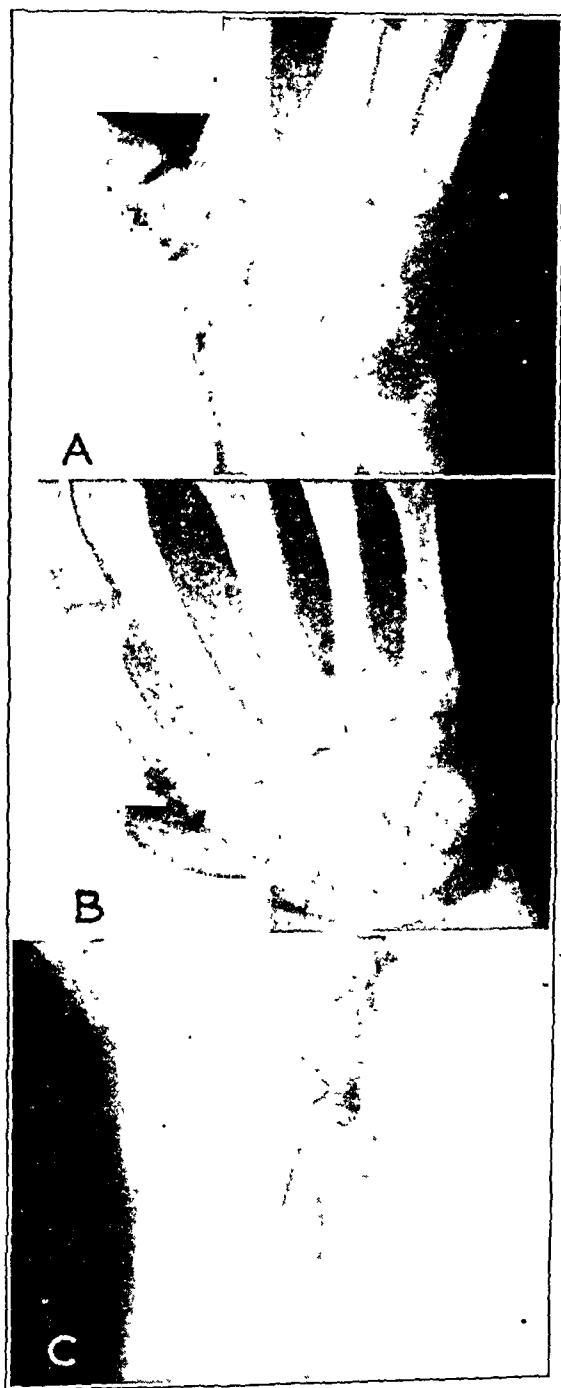


Fig. 4 (case 6).—*A*, preoperative roentgenogram taken in September 1941. *B*, operation in December 1941. The graft is in place. The excess bone is trimmed flush with the scaphoid. *C*, postoperative roentgenogram dated Oct. 11, 1942, indicating union. The end result was good.

fracture site. A small rongeur is used to make a drill starting point at the tubercle of the scaphoid. A $5/64$ inch (0.19 cm.) drill is placed through the tubercle and across the fracture line down to a suitable

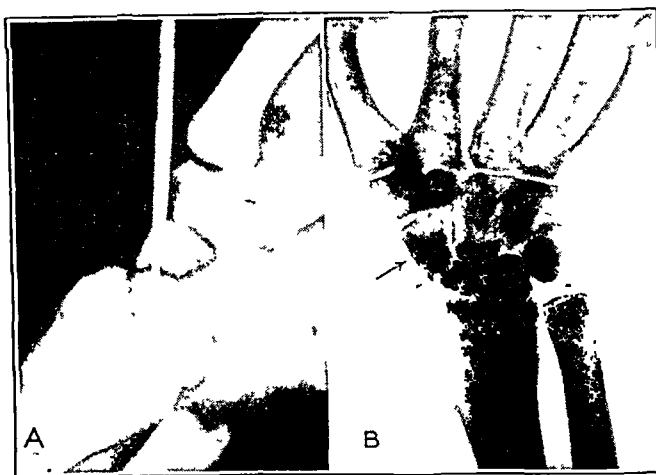


Fig. 5 (case 10).—*A*, operative roentgenogram on Jan. 27, 1942. The fragments were unstable. Curettage was accomplished. Impaction of the fragments is essential. *B*, roentgenogram taken ten months postoperatively indicates union. The end result was excellent.

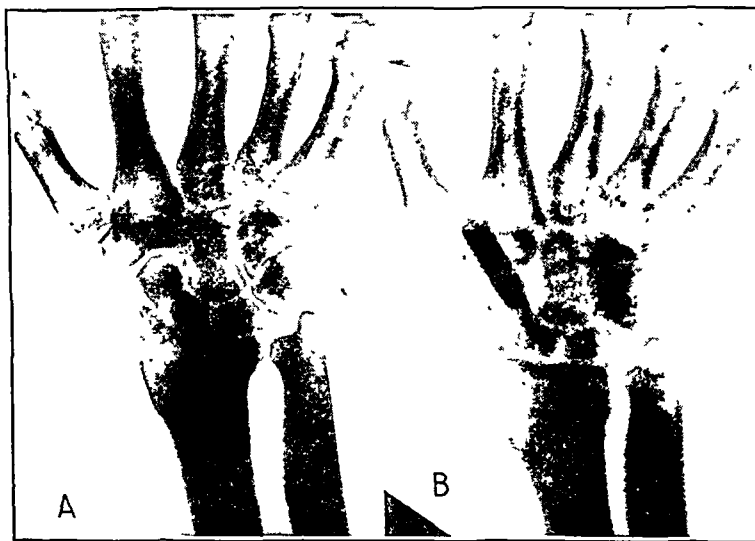


Fig. 6 (case 16).—*A*, preoperative roentgenogram dated August 1942. *B*, operative roentgenogram dated September 1942. Roentgenograms taken in July 1943 showed partial union only. Hand grip was strong, and the patient stated that the "hand is almost as strong as the normal hand." Roentgenograms in early 1945 showed that the bone peg was apparently completely absorbed. There was an excellent union of the fragments. The end result was good.

depth, which can be measured by means of a metal probe. The pneumatic tourniquet is then released, and hemostasis is accomplished. While roentgenograms are being taken, the team prepares a bone graft.

which is best obtained by an electric saw. The graft is suitably fashioned to a slightly greater diameter than the drill point which was used to make the hole in the scaphoid. The peg itself is usually not more than 2 cm. long, although the entire length of the bone may measure 4 cm. This length expedites the tapping of the peg across the fracture line. If the roentgenograms reveal satisfactory position and depth of the drill hole, the graft is then hammered into place, care being taken to impact the fragments. This is readily accomplished by means of a "spud" which holds the proximal end of the scaphoid while the distal end of the peg is tapped on. Another check roentgenogram is taken at this time to make sure that the graft is well across the fracture line. Excess bone is removed from the peg with a cutting forceps. The wound is closed in layers with fine cotton or silk. A plaster cast is applied from the olecranon to the metacarpal-phalangeal joints. It is cut out in such a way as to allow full motion of the finger joints. The thumb is placed in a position of slight abduction and moderate extension. The cast incorporates the thumb down to the interphalangeal joints but allows motion of the distal joint. If the wrist is placed in too much "cock up," undesirable motion of the wrist occurs.

COMMENT

Three additional cases of nonunion of the carpal scaphoid are included in which the proximal fragment in 2 instances and the distal fragment in another was removed (cases 17, 18 and 19). The patients had pain in the wrist and limitation of motion postoperatively. Arthrodesis of the wrist is preferable to excision of one or more carpal bones, which was performed in case 19. This procedure was purposely done rather than a fusion because of marked limitation of motion in the finger joints. The case was one of unrecognized retrolunar dislocation of the capitate and fracture of the scaphoid of two months' duration. It was complicated by paralysis of the median nerve secondary to pressure from the dislocated lunate. At operation it was necessary to remove both the proximal scaphoid fragment and the lunate because the dislocation tended to recur. A radial deviation deformity of the wrist may occur unless a fusion procedure such as the Colonna²⁴ type is performed.

SUMMARY

A review of the literature is presented, including a description of the anatomic, physiologic and pathologic changes resulting from injuries to the carpal scaphoid.

24. Colonna, P.: A Method for Fusion of the Wrist, *South. M. J.* **37**:195-199 (April) 1944.

An analysis has been made of 16 cases of fracture in which non-union of the carpal scaphoid was treated by bone grafting. This includes a study of the end results in periods varying from one to five years.

Healing of the bone occurred in all but 1 of 16 cases in this series. In 6 of these combined operations of preliminary drilling and grafting were performed. The waist of the bone was involved in all but 1 of the cases. In the latter the proximal one third was the site of fracture. In 3 of the cases curettage of the surfaces of the fracture fragments was done. This procedure does not seem to be necessary. A study of the excellent results in this series indicates that in the more chronic cases in which there is no roentgenologic evidence of arthritis good function may be expected, particularly if good wrist motion existed prior to operation. The chief indication for operation was pain. A good prognosis can be expected in properly selected cases in which a bone peg is used. Only patients with definite disability should be urged to have the open operation of bone pegging.

For ancient fractures associated with a degenerative arthritis, wrist fusion should be strongly considered. If manual labor is not required of the patient, excision of the proximal fragment may be the procedure of choice. Arthrodesis can be done later if necessary. The proximal carpal row may be advantageously excised in some of these cases, and more particularly in instances of retroulnar dislocation of the capitate and fracture of the scaphoid bone.

REACTION IN SURGICAL WOUNDS TO SURGICAL GUT, SILK AND COTTON SUTURES

MORTON D. PAREIRA, M.D.
ST. LOUIS

PROVIDING that a suture material can be rendered sterile without significantly altering its physical state and providing that it endows a wound with sufficient mechanical tensile strength for coaptation over a period well beyond the usual time of appearance of biologic tensile strength, it may be considered for clinical usage. The nonabsorbable materials commonly employed fulfil these requirements, but it has been the experience of many that the commonly used absorbable material, surgical gut, does so only partially.¹

The ultimate criterion, however, in evaluation of a suture material is the degree of foreign body inflammatory response that it incites in living tissue. Of obvious advantage is the use of a suture material found least detrimental to wound healing.

Considerable clinical and experimental data are existent indicating the greater degree of inflammatory response, with consequent higher incidence of wound complications including infection, with the use of absorbable materials.² There has also been presented some data indicating differences in the degrees of reaction incited by the various non-absorbable materials, some finding cotton to be most innocuous.³

Aided in part by the David May-Florence G. May Fund.

From the Department of Surgery, St. Louis Jewish Hospital.

1. (a) Howes, E. L.: The Strength of Wounds Sutured with Catgut and Silk, *Surg., Gynec. & Obst.* **57**:309 (Sept.) 1933. (b) Meade, W. H., and Ochsner, A.: The Relative Value of Catgut, Silk, Linen and Cotton as Suture Materials, *Surgery* **7**:485 (April) 1940. (c) Meleney F. L.: Infection in Clean Operative Wounds: A Nine Year Study, *Surg., Gynec. & Obst.* **60**:264 (Feb.) 1935; (d) The Problem of Catgut Sterility, *Internat. Abstr. Surg.* **71**:422 (Nov.) 1940.

2. (a) Halstead, W. S.: The Employment of Fine Silk in Preference to Catgut and the Advantages of Transfixing Tissues and Vessels in Controlling Hemorrhage, *J. A. M. A.* **60**:1119 (April 12) 1913. (b) Localio, S. A.; Casale, W., and Hinton, J. W.: Wound Healing: Experimental and Statistical Study; IV. Results, *Surg., Gynec. & Obst.* **77**:376 (Oct.) 1943; (c) V. Bacteriology and Pathology in Relation to Suture Material, *ibid.* **77**:481 (Nov.) 1943. (d) Whipple, A. O.: Use of Silk in the Repair of Clean Wounds, *Ann. Surg.* **98**:662 (Oct.) 1933. Howes.^{1a} Meade and Ochsner.^{1b}

3. (a) Meade, W. H., and Long, C. H.: The Use of Cotton as a Suture Material, *J. A. M. A.* **117**:2140 (Dec. 20) 1941. (b) Meade, W. H., and Ochsner, A.: Spool Cotton as a Suture Material, *ibid.* **113**:2230 (Dec. 16) 1939; footnote 1b.

There has been no single quantitative test of tissue reaction to suture materials. Histologic evidence of the cellular response is only qualitative. Statistical assays of specific wound complications with the use of various materials offer only indirect evidence of tissue reaction. I have therefore attempted to devise a method whereby the total tissue reaction to suture materials can be quantitatively determined,

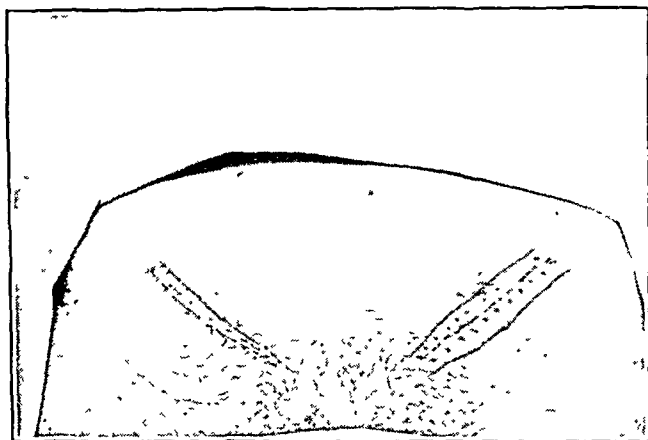


Fig. 1.—Width of subcutaneous induration marked on skin in case of bilateral herniorrhaphy six days postoperatively. Cotton used on right side, chromic surgical gut on left.

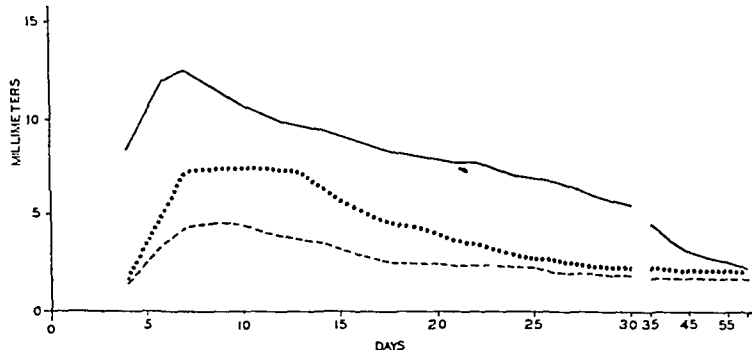


Fig. 2.—Mean induration curves of each group of cases. Cotton, broken line; silk, dotted line; surgical gut, solid line.

and, using the method, have compared the reactions to surgical gut, cotton and silk.

OBSERVATIONS

Method.—The postoperative subcutaneous induration was measured in 30 patients, 10 each for the use of surgical gut, cotton and silk. The patients chosen for these observations were of the same age group and physical status. The same incision, body area, operation (inguinal herniorrhaphy) and surgical technic were employed in all cases, and all operations were done by the same surgeon. In all cases the material under study was used throughout except that nonabsorbable sutures were used for skin closure in all. All sutures were interrupted and of a size only sufficient to coapt tissues. Ordinary untreated cotton and black twisted untreated surgical silk of equal caliber by micrometric measurement were used

Beginning on the second or third postoperative days, and thereafter every two to three days, the edges of induration were delineated by palpation and marked on the skin and the width of induration measured (fig. 1). The margin of induration was distinct to the palpating finger in all instances.

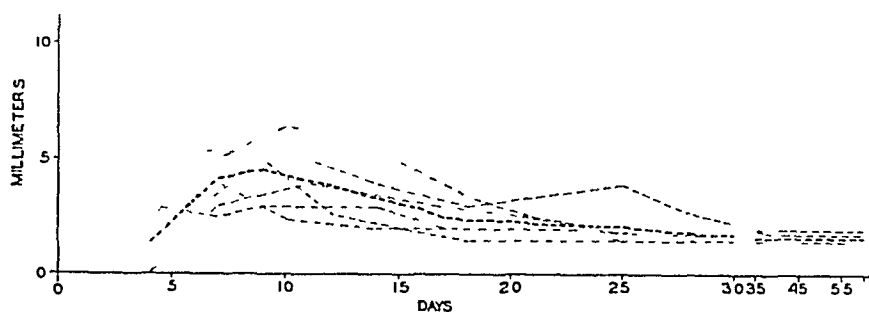


Fig. 3.—Mean induration curve of cotton (heavy line) with sample cases (light lines) to show greatest variability.

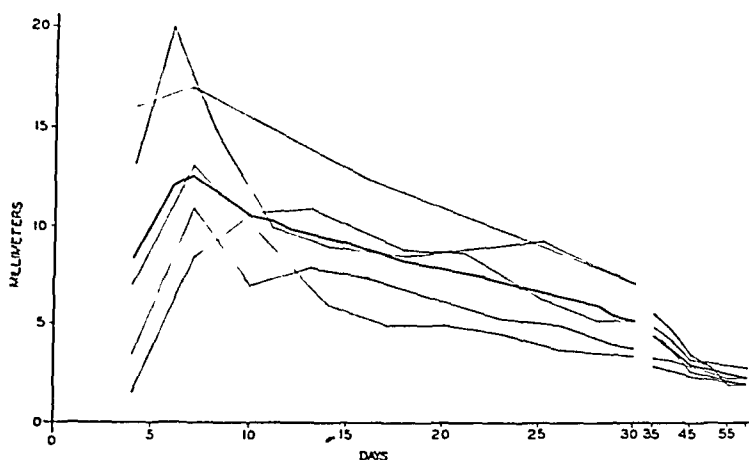


Fig. 4.—Mean induration curve of surgical gut (heavy line) with sample cases (light lines) to show greatest variability.

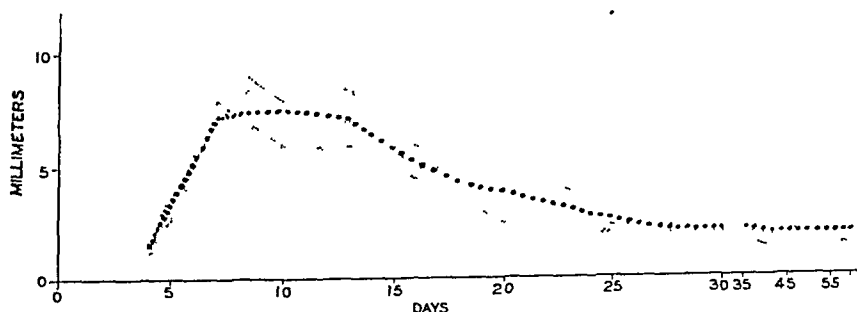


Fig. 5.—Mean induration curve of silk (heavy line) with sample cases (light lines) to show greatest variability.

Results.—Subcutaneous induration was found to appear in all wounds on the third to the fourth postoperative day. After its appearance the degree of induration increased rapidly and usually reached a peak on the sixth to the seventh postoperative day in all wounds and with all materials (fig. 2).

The induration incited by chromic surgical gut was found to be greater than that incited by the nonabsorbable materials and the variations from case to case greater (fig. 4, as compared with figs. 3 and 5). The induration with the use of silk was significantly greater than that with the use of cotton (fig. 2). At the end of two months there was but little difference in the induration of wounds sutured with the various materials (fig. 2).

In addition to careful control in selection of patients and in standardization of surgical technic, certain facts were forthcoming which indicated that the observed differences were not attributable to biologic variation alone. The induration curve of each person approximated the mean curve of the material used. The mean value was statistically significant (figs. 3, 4, 5). In bilateral operations using different materials on each side the same differences in induration were observed (fig. 1).

COMMENT

Our observations have been based on the premise that subcutaneous induration adjacent to a postoperative incisional wound largely represents the inflammatory response of the tissue to exudation, necrosis and foreign body. That exudation per se is not a significant component of the palpable induration is evidenced by the fact that induration does not appear until the third to the fourth postoperative day. Under conditions of the experiment we believe it justifiable to consider the differences in the measured induration of wounds sutured with the various materials directly attributable to the responses specifically incited by each material.

The curves presented indicate a significant difference in tissue reaction to the materials studied, the reaction to surgical gut being greatest, that to silk next and that to cotton least. It is reiterated that meticulous tissue technic must be employed in order that the tissue reaction to non-absorbable materials be minimal, as here depicted.⁴

As has been indicated, at the end of the second month the degrees of induration among the three groups of wounds show little variance. This, we feel, cannot be interpreted to mean that there is no difference in value among the materials studied. In so far as local factors are concerned, it is the amount of reaction present during the period of active healing that determines the susceptibility of surgical wounds to complications.

SUMMARY

1. A method for quantitative measurement of tissue reaction to suture materials is presented.

2. Comparative studies with the use of this method indicate a significantly greater tissue reaction to surgical gut than to cotton or silk and a significantly greater reaction to silk than to cotton.

4. Meade and Ochsner.^{1b} Halstead.^{2a} Whipple.^{2d} Meade and Long.^{3a}

EXTENT OF STRANGULATION OF THE SMALL INTESTINE COMPATIBLE WITH LIFE

Experimental Study

J. GASTER, M.D.

H. A. DAVIS, M.D.

P. A. PRITEL, M.D.

AND

R. L. MARSH, M.D.

LOS ANGELES

SUDDEN interference with the blood supply to the intestines in human beings occurs frequently and has a high mortality rate. The exact degree of acute decrease in blood supply that the human intestine can withstand and still retain viability is unknown. This question is of practical importance when encountered in conditions of strangulated intestinal obstruction, mesenteric thrombosis or embolism and in the preparation of the wall of the bowel for intestinal anastomosis. It is generally accepted that deficient blood supply is an important cause of marginal gangrene in a suture line.¹

Welch and Mall² have shown that if more than 5 cm. of small intestine in the dog is deprived of arterial blood supply, the segment will undergo infarction and gangrene. Eisberg³ also demonstrated that the blood entering through the intramural channels at each end of such a loop could maintain viability in the intestine only for a distance of 3 cm. Niederstien⁴ found that severance of the mesentery of dogs for a distance of 3 cm. caused a superficial necrosis of the mucosa and that at 5 cm. hemorrhage also occurred into the other coats. He found that none of the animals died unless more than 5 cm.

From the Hunterian Laboratory, the Department of Surgery and Graduate School of Medicine, College of Medical Evangelists.

Read by title before the Forum on Fundamental Surgical Problems, Clinical Congress of the American College of Surgeons, New York, September 1947.

1. Mollman, A. H.: End-to-End Anastomosis, *J. Michigan M. Soc.* **40**:882, 1941.

2. Welch, W. H., and Mall, F. P., in Allbutt, T. C.: *System of Medicine*, New York, The Macmillan Company, 1902, vol. 6.

3. Eisberg, H. B.: On the Viability of Intestine in Intestinal Obstruction, *Ann. Surg.* **81**:926, 1925.

4. Niederstien: Die Zirkulationstörungen im Mesenterialgebiet, *Deutsche Ztschr. f. Chir.* **85**:710, 1906.

was cut away, in which case a hemorrhagic infarct developed and death resulted. Schloffer⁵ stated 3 cm. to be the margin of safety in rabbits. These experiments test the adequacy of the collateral circulation existing in the intestinal submucosa. Schloffer emphasized that not all lesions are fatal and many heal completely. Donaldson,⁶ however, has pointed out that a somewhat longer segment of intestine can survive after venous occlusion alone than after arterial occlusion. Laufman⁷ experimentally produced gradual complete occlusion of the superior mesenteric artery and vein, and the animals lived.

When the interference with the blood supply is gradual, an adequate collateral circulation can develop. However, when the blood supply through the intestinal arteries is suddenly shut off, the intestine has to rely entirely on the blood entering through the intramural channels. The present study was undertaken to determine the length of devascularized bowel which could be revascularized sufficiently to prevent gangrene and perforation.

MATERIAL AND METHODS

Rabbits were the experimental animals selected because Noer⁸ has shown that their mesenteric vascular pattern is more similar to that of human beings than the mesenteric vascular pattern of all other laboratory animals.

With aseptic precautions and under ether anesthesia, the ileum was exposed through an abdominal incision and different lengths of ileum were devascularized. The arcuate artery and vein and vasa rectae were doubly ligated at one point, and the vessels were cut between the ligatures. (No. 30 white cotton was used throughout.) The defect in the mesentery thus produced was carried right down to the wall of the bowel in one direction and in the opposite direction was brought to the intestinal artery and vein, which was also doubly ligated and cut between the ligatures. The defect in the mesentery was then carried to the arcuate vessels and vasa rectae of the opposite side, where the same procedure was carried out. The incision in the mesentery was again brought to the wall of the bowel, a triangular-shaped defect in the mesentery thus being produced. The mesentery was extremely thin, and therefore no attempt was made to close this triangular defect. At the close of the operation the only blood coming to the devascularized area was through the fine intramural vessels at each end of the ligated segment. (Dwight,⁹

5. Schloffer, H.: Ueber Darmstrikturen nach Unterbrechung der mesenterialen Blutzufuhr, *Mitt. a. d. Grenzgeb. d. Med. u. Chir.* **14**:251, 1905.

6. Donaldson, J. K.: A Neglected Type of Venous Mesenteric Occlusion, read before the American College of Surgeons, Boston, November 1941.

7. Laufman, H.: Gradual Occlusion of the Mesenteric Vessels, *Surgery* **13**:406, 1943.

8. Noer, R. J.: The Blood Vessels of Jejunum and Ileum: A Comparative Study of Man and Certain Laboratory Animals, *Am. J. Anat.* **73**:293, 1943.

9. Dwight, T.: Proceedings of the Tenth Annual Session Association of American Anatomists, 1897; cited by Eisberg.³

Monks¹⁰ and Mall¹¹ have demonstrated free anastomosis within the wall of the bowel.) The lesion thus produced resembles closely that which occurs in man when an embolus lodges in one of the smaller intestinal arteries and a thrombus forms in all the terminal branches as far as the mesenteric attachment to the wall of the bowel. The devascularized loops were returned to the abdomen, which was then closed in the usual manner.

Seven groups of animals were operated on, and increasing lengths of ileum were devascularized as shown in the table.

The operative site was examined at autopsy, after the animal was killed, or at a subsequent exploratory operation.

RESULTS

Group 1 (Devascularization of 5 Cm. of Ileum in 2 Rabbits).—These rabbits had a normal postoperative course, and at exploratory laparotomy ten days later the ligated area appeared essentially normal.

Group 2 (Devascularization of 6 Cm. of Ileum in 10 Rabbits).—One rabbit died on the fifth postoperative day. Autopsy showed the ligated area to be blanched but not gangrenous or perforated. There

Length of Devascularized Areas in Rabbits

Group	Number of Rabbits Operated on	Length of Devascu- larized Area, Cm.
1.....	2	5
2.....	10	6
3.....	12	7
4.....	10	7½
5.....	10	8½
6.....	10	10
7.....	2	13

was diffuse peritonitis, but the origin was not clear. One animal was killed after five weeks. Autopsy showed that the ligated loop had become adherent to itself and to adjacent loops of small intestine. The defect in the mesentery had closed spontaneously. Revascularization had occurred from adjacent loops, from the omentum and from adhesions to the parietal peritoneum. The remainder of the animals are living and well.

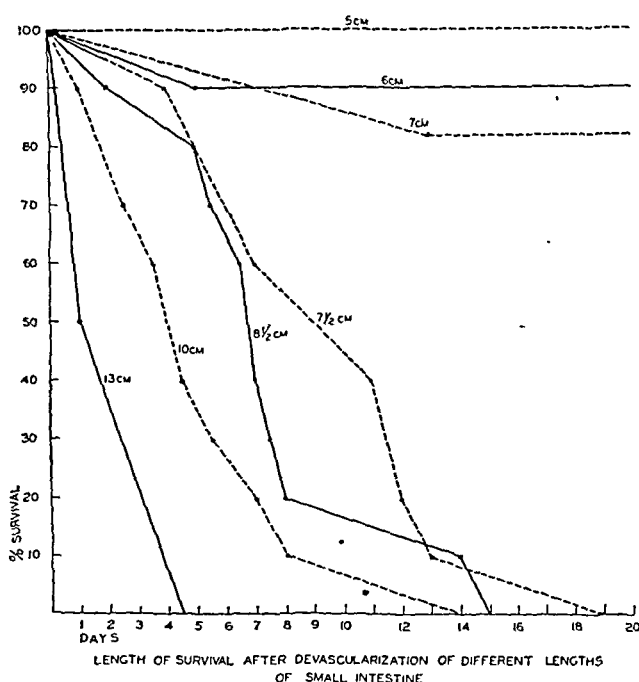
Group 3 (Devascularization of 7 Cm. of Ileum in 12 Rabbits).—Exploratory laparotomy on 1 rabbit on the tenth postoperative day showed a large abscess which resulted from a perforation in the devascularized area of the intestine. The abscess was drained and the perforation closed, and the rabbit recovered. Our experience with this type of lesion has been that the perforation in the intestine continues to feed the abscess, which grows and eventually ruptures,

10. Monks, G. H.: Intestinal Localization, *Ann. Surg.* **38**:574, 1903; cited by Eisberg.³

11. Mall, F. P.: Die Blut-und Lymphwege im Dünndarm des Hundes, *Abhandl. d. math.-phys. Cl. d. k. sächs. Gesellsch. d. Wissensch.*, 1887; cited by Eisberg.³

and produces peritonitis, with a fatal termination. We are therefore counting the occurrence in this animal as a fatality, which would undoubtedly have been the outcome were it not for the operative intervention. One rabbit died on the thirteenth postoperative day from an unrelated condition. One rabbit was killed after five weeks, and the findings at autopsy were the same as in group 2. The remainder of the animals are living and well.

*Group 4 (Devascularization of 7.5 Cm. of Ileum in 10 Rabbits).—*In this group the mortality rate rose sharply (see chart). All the rabbits were dead by the nineteenth day. The autopsy showed that



Length of survival after devascularization of different lengths of small intestine.

perforation and peritonitis were the cause of death in 80 per cent of them. In the remainder, death was not definitely related to the operative procedure. The average length of survival for all the animals in the group was 9.2 days.

*Group 5 (Devascularization of 8.5 Cm. of Ileum in 10 Rabbits).—*The chart shows a shortened duration of life for this group. All the rabbits were dead by the fifteenth day. Autopsy showed gangrene, perforation and peritonitis to be the cause of death in 100 per cent. The average length of survival for this group was 7.7 days.

*Group 6 (Devascularization of 10 Cm. of Ileum in 10 Rabbits).—*The length of survival after devascularization was still further reduced,

as shown by the chart. The findings at autopsy were the same as in group 5. The average length of survival was 5.2 days.

*Group 7 (Devascularization of 13 Cm. of Ileum in 2 Rabbits).—*One rabbit died twenty-four hours after operation and the second rabbit four and a half days after operation. The findings at autopsy were the same as in group 5. The average length of survival was 2.8 days.

COMMENT

The sudden removal of the blood supply of 5 cm., 6 cm. and 7 cm. lengths of the small intestine is compatible with life in the rabbit. When larger segments of small intestine were devascularized, gangrene, perforation, peritonitis and death was the usual course of events. It was surprising to observe that some animals with such lengths of devascularized intestine as 8.5 cm. and 10 cm. could survive eight, ten, twelve and even fourteen days.

When 5 cm. of intestine was devascularized, the intestine was able to maintain viability by the blood entering through the intramural vessels at each end. When longer areas were devascularized, however, this was insufficient to maintain viability, and the blood supply was seen to come from four sources: (1) adherent, adjacent loops of intestine, (2) ingrowth of new blood vessels into the closed, healed mesentery, (3) the omentum and (4) vascularized adhesions to the parietal peritoneum. These methods of revascularization are graphically demonstrated in an article recently published.¹² The well known protective effect of the omentum in helping to revascularize an injured area is experimentally demonstrated.

These experiments closely reproduce the condition that exists in acute mesenteric thrombosis or embolism, in strangulated intestinal obstruction and in stab wounds of the mesentery. It is well known¹³ that there are many cases of mesenteric thrombosis or embolism that go undiagnosed. Recovery without operation does not exclude the diagnosis of thrombosis or embolism of the superior mesenteric vessels or their branches. In this process the role of the omentum is self evident, not only in walling off infection but also in aiding revascularization.

12. Davis, H. A.; Gaster, J.; Marsh, R. L., and Pritel, P. A.: The Effect of Streptomycin in Experimental Strangulation of the Small Intestine, *Surg., Gynec. & Obst.* **87**:63, 1948.

13. Klein, E.: Embolism and Thrombosis of Superior Mesenteric Artery, *Surg., Gynec. & Obst.* **33**:385, 1921.

SUMMARY

Devascularization of small intestinal loops up to 7 cm. in length was compatible with life. Removal of the blood supply to areas of bowel more than 7 cm. in length usually caused death from gangrene and perforation of the affected loop. The duration of life after devascularization of the bowel is inversely proportional to the extent of bowel which has been deprived of its blood supply.

OSTEOID OSTEOMA

Report of a Case with Probable Double Lesion

PAUL W. LAPIDUS, M.D.

AND

EDWARD P. SALEM, M.D.

NEW YORK

OSTEOID osteoma was first described in detail by Jaffe¹ as a definite clinical entity in 1935. He considered it to be "a benign osteogenic tumor of slow growth."

Prior to Jaffe's paper, this lesion had apparently been diagnosed as "sclerosing nonsuppurative osteomyelitis," "chronic sclerosing osteitis" (Henderson,² 1924), and "sclerosing osteomyelitis of Garré" (Ewing, 1942, and Wishner,³ 1933). The sclerosing osteomyelitis described by Garré⁴ in 1891 most probably also represented the osteoid osteoma.

Quite a few cases of osteoid osteoma have been recorded subsequent to Jaffe's publication.^{4a} However, this condition, which is not extremely rare, still not infrequently remains unrecognized. The authors wish to record a case apparently presenting two osteoid osteomas, one in the neck and another in the shaft of the right femur of the same patient. In all cases thus far reported a single lesion was present, and there-

From the service of Dr. Leo Mayer and Dr. Henry Milch, Hospital for Joint Diseases, and the service of Dr. A. Bingham, New York Medical College, Flower and Fifth Avenue Hospitals.

1. Jaffe, H. L.: Osteoid Osteoma: A Benign Osteoblastic Tumor Composed of Osteoid and Atypical Bone, *Arch. Surg.* **31**:709-728 (Nov.) 1935.

2. Henderson, M. S.: Chronic Sclerosing Osteitis, *J. A. M. A.* **82**:845-942 (March 15) 1924.

3. Wishner, J. G.: Chronic Sclerosing Osteomyelitis (Garré), *J. Bone & Joint Surg.* **15**:723-732 (July) 1933.

4. Garré, C.: Einige seltene Erscheinungsformen der akuten infektiösen Osteomyelitis: Festschrift zum 25 jährigen Doktor-und Dozenten-Jubilaum von Theodor Kocher, Wiesbaden, J. F. Bergman, 1891, vol. 1, p. 43; Ueber besondere Formen und Folgezustände der akuten infektiösen Osteomyelitis, *Beitr. z. klin. Chir.* **10**:241, 1893.

4a. Wallace, G. T.: Some Surgical Aspects of Osteoid Osteoma, *J. Bone & Joint Surg.* **29**:797-780 (July) 1947. Jaffe, H. L., and Lichtenstein, L.: Osteoid Osteoma: Further Experience with This Benign Tumor of Bone with Special Reference to Cases Showing the Relation to Shaft Cortices and Commonly Misclassified as Instances of Sclerosing Non-Suppurative Osteomyelitis of Cortical Bone Abscess, *ibid* **22**:645-682 (July) 1940.

fore our case must be considered the first on the record in which there was probable double lesion.

CLINICAL PICTURE

Osteoid osteoma is apparently a benign localized bone tumor. It occurs mostly in children or young adults, male or female. It is not associated with fever.

Ponseti and Barta⁵ reported a lesion in the lower end of the fibula in a 14 month old girl with symptoms present since the age of 10 months. Hamilton⁶ and one of us (P. W. L.^{6a}) recorded an osteoid osteoma of the neck of the talus in a 40 year old woman and of the neck of the femur in a 40 year old man respectively.

The patient usually complains of recurrent attacks of dull ache, mostly at night, not aggravated by activity. The pain is promptly relieved by acetylsalicylic acid, and many patients carry tablets and take them periodically at the onset of pain.

There may be local tenderness and occasional swelling. Limp and limitation of motion may be present from a periarticular lesion (Sherman⁷). Torticollis was noted in the involvement of cervical vertebra, scoliosis in a case of a lesion of the ninth rib, varus deformity of the foot with the lesion in the lower end of the fibula and medial bowing of the leg due to osteoid osteoma in the upper medial region of the tibia, reported by Ponseti and Barta.

The lesion may be localized in almost any long or cancellous bone, although it seems to favor certain parts of the skeleton, such as the shaft of the tibia, lower portion of the neck of the femur, anterior part of the os calcis, vertebral laminae, upper part of the neck of the talus, phalanges of the feet and hands and tarsal and carpal navicular bones. Osteoid osteoma has also been found in the pelvis, skull, humerus, radius, ulna, rib, femoral condyles and patella.

Roentgenograms are often characteristic and suggestive of the lesion. There is an area of dense, sclerosed bone in the middle of which a small round nidus of rarefaction is found. Sometimes the nidus itself is surrounded with a thin circle of radiotranslucency. The sclerosing changes may be extensive in the case of involvement of the long bones, and may often obscure the nidus. Several slightly overexposed roent-

5. Ponseti, I., and Barta, C. K.: Osteoid Osteoma, *J. Bone & Joint Surg.* **29**:767-776 (July) 1947.

6. Hamilton, J. F.: Osteoid Osteoma with Case Reports, *Surg., Gynec. & Obst.* **81**:465-474 (Nov.) 1945.

6a. Lapidus, P. W., and Wilson, M. J.: Osteoid Osteoma: Report of Three Cases, *Bull. New York M. Coll., Flower & Fifth Ave. Hosps.* **37**:44, 1947.

7. Sherman, M.: Osteoid Osteoma Associated with Changes in Adjacent Joint: Report of Two Cases, *J. Bone & Joint Surg.* **29**:483-490 (April) 1947.

genograms from different angles may be necessary before the nidus may be visualized.

As shown by MacKenzie⁸ and others, the roentgenographic changes are slowly progressing and the nidus may become visible only in the later stage of the illness. Laboratory examinations of urine, blood (including sedimentation rate), calcium, phosphorus and phosphatase have always shown these to be normal. Likewise the cultures from the lesion have always remained sterile.

The pathologic picture is also characteristic. Macroscopically, in fresh specimen there is a reddish round area about 0.5 to 1.0 cm. in diameter, sharply demarcated from the yellowish surrounding bone (figs. 2 and 5 A). On microscopic section the nidus consists of a vascular, richly cellular embryonal type of osteoid tissue containing osteoblasts and osteoclasts. Often the nidus may be found only after thorough sectioning of the entire specimen.

It is helpful, for confirmation of the diagnosis, to take roentgenograms of the specimen from different angles. On some views the nidus may be well noticeable, while on others it may be completely overlapped by the sclerosed bone (fig. 3).

The osteoid osteoma, as has already been stated, always has a benign course. Metasis of the lesion has never been observed.

Thorough surgical removal of the lesion together with a block of surrounding bone is the only treatment thus far tried and brings prompt relief. The typical pain is promptly terminated immediately after the operation, and recurrence of the lesion has never been observed. There are, however, a few cases on record in which symptoms persisted because of failure to locate and remove the nidus or because of incomplete removal. In order to avoid these mistakes, it is advisable to take roentgenograms during the operation to assure adequate location and removal of the osteoid osteoma with the surrounding bone.

REPORT OF A CASE

T. B., a 16½ year old white male student, was referred to the office of one of the authors (P. W. L.) by his family physician on Sept. 12, 1946, because of dull, aching pain over the anterolateral aspect of the right thigh, of three or four months' duration. The pain was mostly at night and during the cold rainy weather, and it had become more severe during the last month, preventing him from resting at night. The boy had lost 5 or 6 pounds (2.3 to 2.7 Kg.) during the last three months. The pain was promptly relieved by taking acetylsalicylic acid and was not aggravated by physical activities.

About one year prior to the consultation, while playing basketball, the patient was hit over the right thigh by the head of another player. He was slightly lame

8. MacKenzie, W.: Painful, Non-Suppurative Sclerosis of the Long Bones, *J. Bone & Joint Surg.* 29:49-58 (Jan.) 1947.

for one week after the injury. Physical examination was essentially noncontributory. There was no limp. The boy was able to hop on each foot and could squat without discomfort. There was no muscular atrophy of the lower limbs, and no tenderness could be found. No sensory changes were present, and the deep reflexes

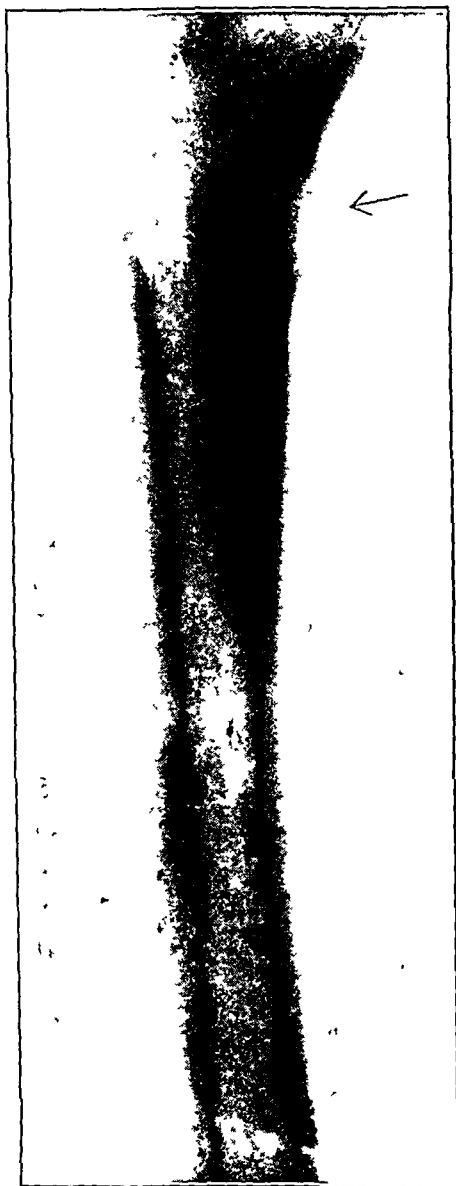


Fig. 1.—Roentgenogram of the right femur. Note considerable sclerosing changes over lateral aspect of the shaft, with what appeared to be a nidus (small arrows) on close study. There seem to be no changes over the upper part of the femur (large arrow).

were equal and normal. The following note was made on the office chart (P. W. L.) after the first examination: "In spite of the practically negative clinical findings the picture is very much suggestive of osteoid osteoma of the shaft of the femur."

The patient was referred to Dr. C. Gottlieb for roentgenographic study.

During the second office visit, on Sept. 16, 1946, a slight limp was noted on the right side. Roentgenograms of the right femur showed a localized sclerosing cortical area up to three quarters of an inch thick (1.9 cm.) over the lateral aspect at the junction of the upper and middle thirds (fig. 1). The roentgenologist reported "periosteal proliferation at the lateral portion of the middle third of the



Fig. 2.—Photograph of the specimen removed at the second operation. Arrows show the nidus. Note that there are several large blood vessels at and around the nidus.

right femur. Since it is at the site of the trauma, it may be of traumatic origin. It does not have the appearance of neoplasm."

However, after thorough study of roentgenograms "a round area the size of a pea, which is surrounded by a thin line of translucent bone which might represent an osteoid osteoma" in the center of the sclerotic area was recorded on the office

chart of one of us (P. W. L.), and a clinical diagnosis of osteoid osteoma of the midshaft of the right femur was confirmed (fig. 1, small arrows).

The patient continued to have attacks of rather severe, mostly nocturnal pain, which was controlled by the use of acetylsalicylic acid.

He was admitted to New York Medical College, Flower and Fifth Avenue Hospitals, on Sept. 23, 1946. Results of physical examination, including the laboratory study, were entirely negative. The patient's temperature, pulse and respiration were normal. A Wassermann test of the blood gave negative results. The hemoglobin content was 100 per cent, 15.6 Gm. per hundred cubic centimeters. The red blood cell count was 5,400,000 and the white blood cell count 9,200, with 64 per cent neutrophils, 2 per cent eosinophils and 34 per cent lymphocytes. The sedimentation rate (Westergren) was 4 mm. in sixty minutes. The blood calcium was

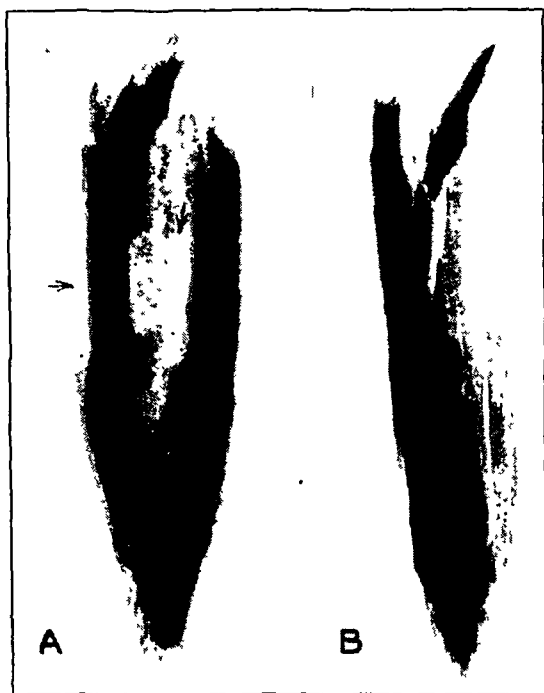


Fig. 3.—*A*, roentgenogram of the same specimen showing the nidus (arrows). *B* lateral view of the same specimen with the nidus being overlapped by the sclerosed bone and not visible. This may explain the frequent difficulty in visualizing the nidus.

10.82 mg. and the phosphorus 3.19 mg. per hundred milligrams. The value for alkaline phosphatase was 11.6 and for acid phosphatase 4.4. The urine was normal.

At the operation performed by the senior author (P. W. L.) on Sept. 24, 1946, a sharp exostosis shaped like an old-fashioned razor blade, with its broad base attached to the anterior lateral surface of the femoral shaft and its sharp edge protruding anteriorly and medially, and being parallel to the femoral shaft, was found. The exostosis terminated distally in a sharp, spearlike point. The entire exostosis was removed together with a piece of sclerosed cortex about $2\frac{1}{2}$ inches (6.3 cm.) long and 0.5 inch (1.2 cm.) wide.

The day after the operation the patient reported that he had "no usual pain last night." On the ninth postoperative day (Oct. 3, 1946) he stated that "pushing" preoperative pain had disappeared, but he felt "throbbing, drawing pain."

The postoperative recovery was uneventful. The wound healed per primum, and the patient left the hospital on Oct. 20, 1946, after about a four weeks' stay. The pathologic study of all the removed bone fragments by Dr. G. K. Higgins, professor of pathology, on "numerous sections, failed to reveal the changes in the bone which characterize osteoid osteoma." Likewise, the roentgenograms of these bone fragments failed to show any lesion.

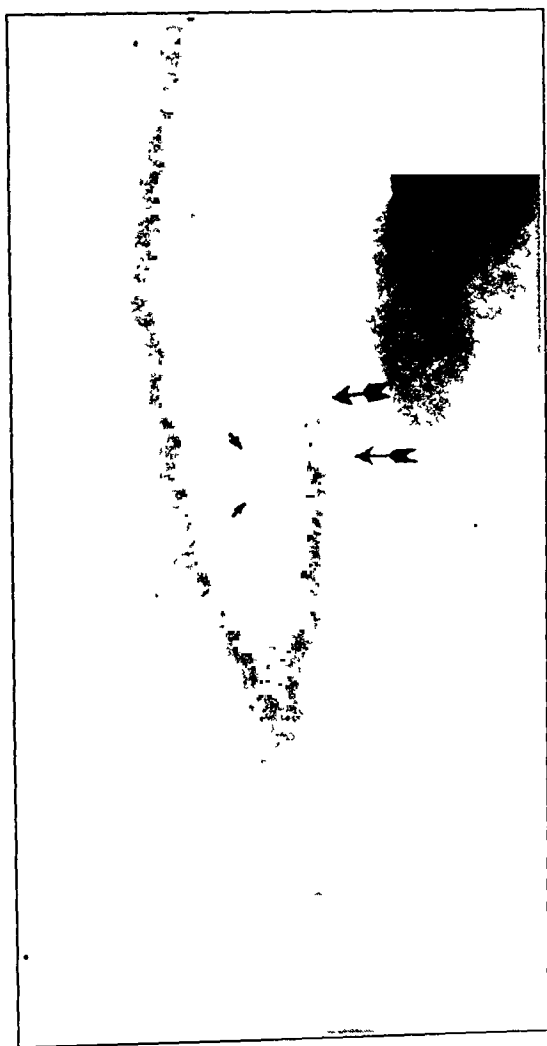


Fig. 4.—Roentgenogram of the upper part of the right femur showing periosteal proliferation (large arrows) and a nidus (small arrows) in the center of sclerosed bone.

After discharge from the hospital, the patient continued to have attacks of pain, mostly nocturnal, over the lateral aspect of the right thigh, which required one tablet of acetylsalicylic acid in every four hours. The roentgenograms of the right femur showed postoperative bone defect, but no definite nidus could be made out although "in one spot over the upper part of the defect a suspicious area" seemed to be present. There was practically no local tenderness on pressure. It was thought that the osteoid osteoma was not removed.

On Nov. 12, 1946, the patient was readmitted to New York Medical College, Flower and Fifth Avenue Hospitals. The clinical and laboratory findings were again negative, except that there were slight atrophy of the right thigh and slight limitation of flexion of the right knee and the right knee jerk was now absent.

On November 13 a second operation was performed (P. W. L.). A large bone block, $3\frac{1}{4}$ inches (8.2 cm.) long and 1 inch (2.5 cm.) wide was removed through the entire cortex down to the bone marrow. A nidus the size of a pea was found in the upper portion of the removed bone (fig. 2). Dr. G. K. Higgins,



Fig. 5.—*A*, photograph of the specimen removed near the lesser trochanter showing typical osteoid osteoma. *B*, roentgenogram of the same specimen showing the nidus (arrows). *C*, different view of the same specimen, on which the nidus is not so well demonstrable. Note several blood vessels around and in the center of the nidus.

after macroscopic examination of the specimen, reported "osteoid osteoma (gross diagnosis)" and considered the changes typical. Unfortunately no microscopic examination could be made, since the specimen became deteriorated after prolonged decalcification. Roentgenograms of the removed specimen showed a round area of rarefaction also typical of osteoid osteoma (fig. 3*A*).

The patient made uneventful postoperative recovery and was discharged on the seventh postoperative day (November 20). For the first two days after the operation he seemed to be relieved; later on, however, his local pain recurred and even became more intense, requiring four or five tablets of acetylsalicylic acid every twenty-four hours. At first the patient localized his pain over the lower two

thirds of the right thigh. On November 29 a sudden attack of "severe pain which was localized in the right knee" and disappeared within ten minutes after a tablet of acetylsalicylic acid was taken was recorded on the office chart (P. W. L.). Since one of us (P. W. L.) was reasonably sure that he succeeded in removing the entire lesion at the second operation, he was baffled by the persistence of severe pain.

The patient was hospitalized for the third time, this time as a ward patient on the service of Dr. L. Mayer and Dr. H. Milch at the Hospital for Joint Diseases, on Feb. 13, 1947. He still complained of dull, aching pain over the lateral aspect of the right thigh and sometimes in the right knee. Pain recurred every four hours regardless of activity or rest, and was relieved by a tablet of acetylsalicylic acid.

Roentgenograms of the middle third of the right femur (Feb. 17, 1947) were reported by Dr. M. Pomeranz as showing "several sclerotic nubbins within the excavated area which may represent the original osteoid osteoma." The roentgenologist's report on February 20 read as follows: "Planigraphic films reveal several circular densities at the base of the excavated area (site of previous operation) which probably represent a residuum of osteoid osteoma. Examination of the right hip joint discloses an irregular periostitis and thickening of the lesser trochanter of the femur. The cortex is moderately eburnated and thickened, and within it a linear nubbin of bone is noted which is likewise strongly suggestive of an osteoid osteoma" (fig. 4). The same changes over the lesser trochanter were noted by Dr. M. Pomeranz on several subsequent roentgenograms.

During extensive preoperative observation one of us (E. P. S.), then a resident surgeon, pointed out that "there may be increased tenderness which is localized approximately at the level of the lesser trochanter." Slight limitation of motion in the right hip joint was also observed by a few members of the staff, some of which even considered the possibility of a "psychogenic origin" of pain.

On February 25 infiltration with 30 cc. of 1 per cent procaine hydrochloride solution along the lateral aspect of the femur at the site of previous operation was performed at the height of the attack of pain, and the patient was not allowed to take his usual dose of acetylsalicylic acid. After this, complete relief of pain in the right thigh and knee was obtained. This lasted for over fifteen minutes, and then pain recurred; the patient was permitted to take acetylsalicylic acid, and within half an hour all symptoms had subsided. The next day the same infiltration, but with sterile water, failed to give him any relief. Similar infiltration with procaine hydrochloride solution was carried out with the point of the needle at the lesser trochanter under roentgen ray control, and again the patient was relieved from pain for about twenty minutes, after which the pain recurred in the knee, but not in the thigh, and again disappeared thirty minutes after a tablet of acetylsalicylic acid was taken.

These procedures seemed to exclude psychogenic origin of the pain but were inconclusive concerning the location of the lesion. The staff was divided in two groups, one (including P. W. L.) suspecting persistence of the lesion over the femoral shaft previously operated on, and another, including Dr. L. Mayer, believing the symptoms to be due to an osteoid osteoma at the lesser trochanter. (One of us, E. P. S., was especially emphatic in the latter interpretation, for which the senior author wishes to give him due credit).

Finally, it was decided to explore first the region of the lesser trochanter and, if no osteoid osteoma was found there, to expose again the lateral aspect of the femoral shaft.

On March 3, 1947, the region of the lesser trochanter of the right femur was explored. Periosteal roughening was found over the anterior aspect of the femur at the base of the lesser trochanter. A block of bone about 1 inch (2.5 cm.) long

and 0.75 inch (1.9 cm.) wide was removed over the roughened area. A definite nidus obviously representing osteoid osteoma was found on its deep surface, on the lifting of the block of bone (fig. 5 *A*). Roentgenograms taken at the operation showed removal of the bone at the site of the lesion.

The patient made satisfactory postoperative recovery. His "typical pain" disappeared the day after the operation, and he has remained entirely free of pain.

Pathologic examination of the specimen by Dr. H. L. Jaffe was reported to show typical "osteoid osteoma." The roentgenograms of the specimen also showed the typical picture of osteoid osteoma (fig. 5 *B* and *C*).

When last seen in the office, on Aug. 28, 1947 (six months after the last operation), the patient was completely asymptomatic; he gained 30 pounds (13.6 Kg.) and has been indulging in athletics.⁹ There was normal function of the right lower limb, although it still showed some muscular atrophy, and the right knee jerk was still absent.

Roentgenograms of the right hip and right femoral shaft showed filling of the bone defect in both places, with diminution of the sclerosing area over the femoral shaft.

COMMENT

In all up-to-date recorded cases of osteoid osteoma a single lesion was present. Therefore, our case seems to be the first on record in which an apparently double lesion was present. It is of course fully realized by us that this case cannot be considered as one in which there was a definitely proved double lesion because of the most unfortunate lack of microscopic diagnosis of the specimen removed at the second operation. However, the typical appearance of this specimen (fig. 2), which was macroscopically diagnosed as unquestionable osteoid osteoma by Dr. G. K. Higgins, Professor of Pathology of New York Medical College, and most typical roentgenograms of the specimen (fig. 3 *A*) together with the clinical picture and the presence of definitely proved osteoid osteoma over the lesser trochanter seem to justify our assumption that the lesion over the lateral aspect of the femur was also an osteoid osteoma.

SUMMARY

Osteoid osteoma is a benign, slowly growing bone tumor. Its clinical symptoms and treatment are briefly discussed. All cases recorded thus far presented a single osteoid osteoma. A case is reported which is the first on record in which there was an apparently double lesion—one, definitely proved, over the lesser trochanter of the femur and another over the lateral aspect of the shaft of the same femur, inadvertently not confirmed microscopically. Symptoms persisted after removal of the lesion over the femoral shaft, and only after removal of the osteoid osteoma near the lesser trochanter was complete relief obtained.

9. Up to the time this proof was read, Feb. 3, 1949, the patient has remained perfectly well.

Surgical Clinics

CYSTIC EMPHYSEMA OF THE LUNGS

W. EMORY BURNETT, M.D., AND STAFF, OF THE TEMPLE UNIVERSITY MEDICAL SCHOOL
PHILADELPHIA

The Chest Conference, held in the X-Ray Museum, Temple University School of Medicine, Philadelphia, convened at 5:10 p. m., Chairman W. Edward Chamberlain presiding.

DR. CHAMBERLAIN: May I call the Chest Conference to order and say that today's conference is being recorded by stenotype to be transcribed for publication? For that reason, I would ask everyone to speak distinctly and to the point. As usual, our discussion will be extemporaneous, but we should be brief.

Will you introduce the case of J. T., Dr. Rosemond?

DR. ROSEMOND: J. T. is a 42 year old man. He was admitted for investigation of pulmonary complaints. He states that for the past seven years he has had increasing dyspnea on exertion, associated with chronic productive cough, but no hemoptysis or pain in the chest. His attacks of dyspnea responded to epinephrine hydrochloride for a time but no longer do so. Skin tests revealed allergy to ragweed, house dust and milk. Dyspnea has become markedly increased in the past few months. The patient has lost approximately 50 pounds (22.7 kg.) in weight.

A cholecystectomy for chronic calculus cholecystitis was performed under spinal anesthesia two months before this admission. The patient recovered from this without difficulty.

On physical examination, he appeared to be a man of average development but in some respiratory distress, even while lying quietly in bed with the head elevated. There was evidence of recent loss of weight, slight bilateral cervical lymphadenopathy and signs of emphysema bilaterally in the chest, with retraction in the supraclavicular and suprasternal regions on inspiration. The trachea was deviated to the right. There were dry rales at both bases. The rate and rhythm of the heart were normal. Abdominal examination revealed nothing abnormal except for a transverse scar in the upper right quadrant. There was no edema of the ankles, and the blood pressure was 102 systolic and 70 diastolic. The blood count on his admission to the hospital and the urine were normal. Examinations of the sputum revealed no acid-fast rods. Examination of the electrocardiographic study of the heart showed no evidence of disease. The patient was afebrile on admission.

DR. CHAMBERLAIN: Our first roentgenologic study of this man is dated Dec. 26, 1946, at which time we visualized emphysematous blebs in both lungs. The important thing to remember about roentgenologic studies in this condition of bullous emphysema or of emphysematous blebs is that there is usually much more pathologic change than shows on the roentgenograms. We do not expect to visualize all these thin-walled bullae or blebs. One does pick them up by the visualization of their walls and by margins of spherical spaces which are seen here and there.

It takes only a moment to notice that there are some large blebs showing in the lateral projection that are not visible in the ventral projection. We are not

able to check the ventral projection against the lateral with any degree of complete correlation. That in itself indicates that there is more present in the way of emphysematous blebs than one would expect from just a cursory reading of the roentgenograms

When the patient was reexamined on Feb. 7, 1947 (fig. 1A), the roentgen appearance had not changed measurably. The most recent roentgenograms, of Oct. 22, 1947 (fig. 1B), show rather a thinner wall around the biggest bleb at the base of the right lung, and some thin lines here and there, which indicate

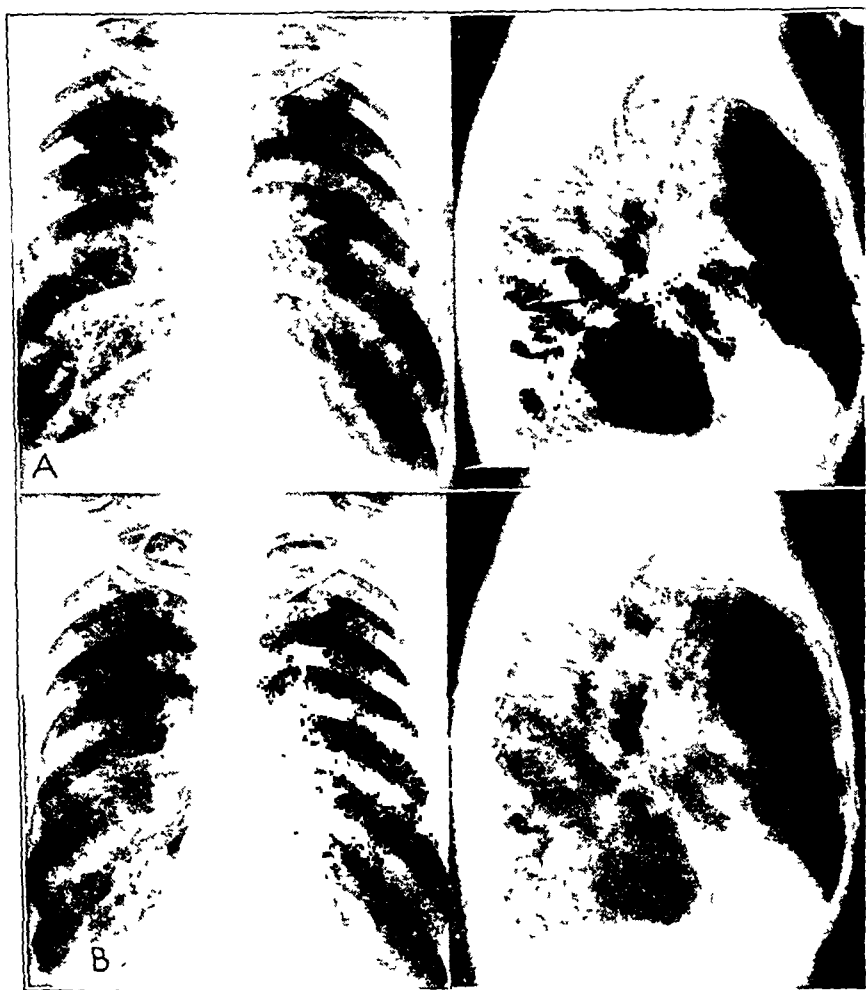


Fig. 1 (case 1, J. T.)—A, Feb. 7, 1947. Ventral and right lateral projections showing bullous emphysema of both lungs. "Blebs" of all sizes are seen. Many of those seen in the lateral projections elude identification in the ventral projection and vice versa. B, Oct. 22, 1947. Many of the blebs show thinner walls than were manifest on the February roentgenograms. This is believed to indicate a decrease in the element of infection.

a widespread involvement; in other words, there are blebs elsewhere than at the place where a definite margin is seen. Again, in the lateral projection, we note evidence of sizable blebs that are not seen with the ventral projection.

The most recent roentgenograms suggest that there is less infection than there was at the examination of Feb. 7, 1947, and earlier. That is because the walls have become thinner; the blebs are much more thin walled than they were. I suspect that the element of infection has quieted down a lot, but I do not think that the mechanical situation has changed in any way.

What about bronchoscopy, Dr. Norris?

DR. NORRIS: Bronchoscopy in this case showed nothing except diffuse inflammatory changes bilaterally and a little tenacious mucoid secretion. There was nothing obstructive anywhere in the accessible bronchial tree. We obtained a specimen for culture.

DR. CHAMBERLAIN: That was sent for bacteriologic study.

Dr. Spaulding, do you have the reports for J. T.?

DR. SPAULDING: I have records of two sputum cultures. One contained hemolytic streptococci and pneumococcus type 13; the other showed type 28 pneumococcus and diphtheroids. Thus, three different organisms were isolated, and the two cultures were different. The higher types of pneumococcus are generally considered insignificant, and since the streptococcus is not designated as belonging to group A, neither organism is a primary pathogen. The diphtheroid is not pathogenic. Although we have not excluded the possibility that these organisms may have played a role in this case, the findings are not clearcut.

DR. CHAMBERLAIN: Dr. Burnett, what is your comment on this case?

DR. BURNETT: We felt that the mechanical phase was of questionable importance and that bronchospasm, allergy and cardiac function might be contributory. I asked Dr. Durant to examine the patient from the medical angle and to review the cardiac findings. Dr. Durant, would you express your opinion of this patient?

DR. DURANT: I saw him on February 17, and at that time he gave a history of having had considerable quantities of purulent sputum and did not remember how far back the expectoration began but knew it had been present for a considerable period. His asthmatic breathing had been largely due to expiratory difficulty and had been relieved promptly by administration of epinephrine hydrochloride. I think that is a feature that is frequently seen in these cases. The bronchospastic features are often relieved by the usual bronchodilators, and such, "luasmin," were prescribed.

It was my impression that the amount of purulent sputum here was suggestive of suppurative pneumonitis, probably secondary to the cystic disease. This could in turn be responsible for the asthmatic breathing on the basis of bacterial sensitization. I suggested mapping the right lung to determine the presence of bronchiectasis. His cardiac status was entirely satisfactory.

DR. CHAMBERLAIN: "Lipiodol" bronchography has not been used in examination of this man's chest. The element of pneumonitis cleared up pretty rapidly, and there is much less evidence of abnormality in the more recent roentgenograms. I think, of course, that the chest should be mapped if surgical intervention is going to be considered. The first question which the surgeons wish us to help to decide is whether this is a suitable case for surgical treatment. Of course, the question in my mind arises from the diffuse involvement. We know that there are blebs in many areas and probably others that do not show on the roentgenogram.

DR. BURNETT: We feel, too, that the bronchospasm is a big element in the production of this type of cyst or bulla and of the blebs under the pleura. We felt that there was a certain amount of infection, as indicated by his symptoms and by the roentgenograms. It was because of that and of the results of studies of the pulmonary functions, which I will give in a moment, that "lipiodol" was not used, the reason being that we would be unable to follow the minor changes if a good deal of "lipiodol" were trapped in the alveoli. We were not at that time ready to subject the patient to surgical treatment. We were not even certain that he should be subjected to surgical intervention at any time, but we discussed with him the fact that if we did advise removal of some of these large bullae to improve the expansion and aeration it might be combined with sympathectomy or denervation of the hilus, with the hope of decreasing the secretion or spasm of the bronchi.

Before going further, let us give you the results of spirometric studies. Dr. Oppenheimer!

DR. OPPENHEIMER: External spirometric studies gave the oxygen consumption as 166 cc. per minute; rate, 9; tidal volume, 775 cc.; minute volume, 7 liters; ventilation equivalent, 4.2; maximal breathing capacity, 11.2, and reserve, 38 per cent, which is low, 75 being normal.

Bronchspirometric study of the right side showed an oxygen uptake of 540 cc. per minute, the uptake on this side being 74 per cent of the total, as compared to 26 per cent on the left side. The tidal volume was 350 cc., the minute volume 5.9 liters and the ventilation equivalent 1.1.

On the left side the oxygen uptake was 190 cc., representing 26 per cent of the total, and the rate 17; the tidal volume on this side was less than 250 cc., the minute volume 4.2 liters and the ventilation equivalent 2.2.

Spirometric study indicates a poor pulmonary function, with an increased ventilation equivalent indicating less than normal efficiency and with a low reserve.

DR. CHAMBERLAIN: Dr. Oppenheimer, the utilization of oxygen was three times as great on the right side as on the left?

DR. OPPENHEIMER: Approximately, yes—74 per cent on the right and 26 per cent on the left. The tidal volume on the right was 350 cc. and on the left 250 cc., both greatly diminished.

DR. CHAMBERLAIN: I am interested in that. It emphasizes the point made earlier, namely, that the roentgenogram does not show everything that is important in a case of this sort. Here we have three times as much respiratory function on the right as on the left, and from the standpoint of the roentgen findings, you would perhaps say that the greatest involvement was on the right instead of on the left. It shows that there are a lot of changes in this left lung that are not shown on the roentgenogram.

DR. BURNETT: That was another thing that made us question the value of surgical extirpation—the right lung, which appears worse, was doing most of the work. By the way, the studies of pulmonary function were checked and found similar. So the question was whether or not we should continue with the present course or subject this man to a combination of extirpation of the large cysts and sympathectomy or vagectomy of the posterior pulmonary plexus, which could be done at the same time but would have to be done bilaterally eventually to be of much value to him.

On treatment with "luasmin" and inhalation of penicillin, he has improved considerably, although we have not a check-up of pulmonary function, unfortu-

nately. We will get one at an early date. Clinical evaluation shows that he is able to do more and has returned to work as a street car conductor, which, of course, is not a very active occupation. He feels definitely better. His respiratory reserve seems to be somewhat improved, and he looks better and has gained about 12 pounds (5.4 Kg.) in weight. So I think he has improved considerably, and I request the opinion of the Conference as to whether he should continue this program, or whether we should subject him to surgical extirpation of the large bullae.

DR. CHAMBERLAIN: Dr. Oppenheimer, did you give us the date of your studies of pulmonary function?

DR. OPPENHEIMER: February 12.

DR. CHAMBERLAIN: In view of the improvement in the roentgen appearance, not of the mechanical situation but of the element of infection, as shown by the more recent roentgenograms, I would certainly want to see a repetition of those functional studies before we make any final decision in this case. Dr. Burnett, you and I felt that the Conference would gain from a consideration of the cases of H. S., F. S. and E. N. and of some of the other cases of bullous emphysema because they point up the propriety or impropriety of surgical intervention in a case of this sort. Shall we ask the members of the Conference to make their recommendation in this case of J. T. after a discussion of some of these other cases that we want to review today?

DR. BURNETT: I think that will give them additional evidence.

DR. CHAMBERLAIN: This next case, which is somewhat comparable, is that of E. N. Dr. Rosemond, will you introduce the history?

DR. ROSEMOND: Mrs. E. N., a 36 year old white woman, was admitted with a five week history of cough, increasing dyspnea, nausea, vomiting and loss of weight. The cough had become more irritating and was productive at the time of admission. *The onset of these symptoms began rather suddenly with a pain in the right side of the chest which was accentuated by deep breathing.* The cough and dyspnea had gradually progressed. There had been no orthopnea or edema of the ankles.

The patient stated that she had pertussis as a child and that in 1920 she had pleurisy which kept her in bed for several weeks. Otherwise, she had been perfectly well.

She was a well developed woman, lying comfortably in bed, with no respiratory distress. Paroxysms of coughing, dry and nonproductive, were evident but occasional. Her trachea was in the midline. There was hyperresonance over the entire right side of the chest, and posteriorly cavernous breath sounds and egophony could be heard. There was impaired fremitus over the entire right side of the chest. The left side of the chest was normal.

The rest of the physical examination was essentially noncontributory. There was no clubbing of the fingers and no cyanosis. Her blood pressure was normal. During her stay in the hospital, she had a low grade fever, the temperature spiking to between 99.2 and 99.3 daily. Her blood count and urine were normal on her admission to the hospital. Studies for acid-fast rods gave repeatedly negative results. The sedimentation rate and electrocardiograms were within normal limits. Thoracentesis was done shortly after her admission to the hospital, and intracystic pressures of plus 2 to plus 8 were found. This pressure was maintained after removal of 250 to 300 cc. of air. The patient experienced no respiratory distress during the procedure.

DR. CHAMBERLAIN: I think, Dr. Rosemond, that we ought to demonstrate some of our findings at this point. I am leaving J. T.'s roentgenograms on the illuminator because we will go back to them later. Our first examination of E. N. (fig. 2 *A*) showed a combination of factors, a pneumothorax and a large bleb or "balloon cyst" of the right lung. Now, it is with some temerity that I say that a pneumothorax and a bleb are present, because we observed cases right here in this Conference in which there appeared to be a pneumothorax but in which it turned out that there was a bleb, and we have certainly no right to insist that this case is



Fig. 2 (case 2, E. N.).—*A*, Aug. 8, 1944. Large "balloon cyst" accompanied with a recurring or persisting pneumothorax. The thin wall of the "cyst" can be traced where it is seen in profile. The right lung is completely collapsed and lies at and slightly ventrad of the right hilus. A mild degree of mediastinal herniation is visualized just ventral to the heart and aorta. *B*, Oct. 22, 1947, a little over three years after surgical extirpation of the "balloon cyst." From the standpoint of the roentgen appearance the only abnormality is the persistence of mild, generalized emphysema and a few "blebs."

not similar. However, the lung-shaped cyst seems to be divided off all the way around from the rest of the space. I think that this is pneumothorax outside of a large bleb. Such a combination is not infrequent, but it is not met with as often as the uncomplicated bullous emphysema.

We see here an element that has not been demonstrated in this other case and that is mediastinal herniation. I believe that you can see that in this air-filled space here (pointing to anterior mediastinum on lateral roentgenogram of August 8) either one of the blebs or the pneumothorax has gone through in front of the heart to produce this black outline which is characteristic of mediastinal hernia.

DR. BURNETT: Dr. Cohen determined these intracystic or intrapneumatocele pressures. It is his patient. Would you care to discuss these, Dr. Cohen?

DR. COHEN: Very little, except to add more to this history. The patient was dyspneic when I first saw her. In fact, she was extremely dyspneic on exertion. That was her presenting symptom. She was cyanotic, too. The case was referred as one of pneumothorax.

DR. CHAMBERLAIN: Was study of the respiratory physiology done before operation?

DR. COHEN: No.

DR. CHAMBERLAIN: The case occurred before we were doing that routinely.

Dr. Burnett, will you tell us about the operation?

DR. BURNETT: In some of these cases, as probably happened in this one, a valvular mechanism develops which balloons the involved area of the lung into greater and greater size. In this instance, because of the obvious deflation and displacement of the lung, the members of the Conference felt that the patient should be operated on, and she was subjected to operation. We found at the time that there was a small amount of pneumothorax and a large pneumatocele, with multiple smaller ones in the vicinity. All of them, however, were from the apex of the upper lobe, with rather small attachment. It required little dissection to remove the bullous areas and to conserve the upper lobe; so lobectomy was not required. It was easy to withdraw the bulla from the mediastinal herniation. There was no adherence there.

Then, all the bronchial openings having been repaired under positive pressure, the lung was seen to expand to about two thirds of its normal size. It subsequently came out completely with constant suction postoperatively. At first we could not expand it completely, although in some of the other cases complete expansion could be obtained immediately. We have had a recent roentgenogram on this patient, approximately three and a half years after operation. She has had no shortness of breath, cough or other respiratory symptoms and has returned to work. On physical examination, one finds that the wound has healed well, that the chest is resonant throughout—normal resonance and not hyperresonance—that the breath sounds are normally heard and that the diaphragm is moving on both sides. Will you demonstrate the follow-up roentgenogram?

DR. CHAMBERLAIN: Yes. The most recent roentgenograms are surprising—three years and two months after operation (fig. 2 B). The roentgen appearance speaks for itself. It is extraordinarily normal. Apparently the surgeons sneak these things out without doing even a rib resection. I cannot find the expected evidence of thoracic surgery here, Dr. Burnett. Do you not take the ribs out any more?

DR. BURNETT: Sometimes we do, but in this instance we did an inframammary incision, i.e., went through the third interspace anteriorly as we usually do for pneumonectomy or upper lobectomy. No deformity resulted.

Dr. Peale has the pathologic report, if he will be kind enough to give it to us.

DR. PEALE: The specimen as we received it was a cystic structure which, when opened, measured 20 cm. in diameter. The outer surface was relatively smooth. The inner surface was trabeculated. Accompanying this cyst was an irregular fragment of additional tissue.

This microscopic section is through the contiguous pulmonary tissue. I think you can see these areas where alveolar walls have broken down and coalesced and formed cystlike spaces. Then, here and there we see the terminal bronchial branches standing out as thick-walled structures which are penetrated by a few inflammatory cells. Then, in the areas spreading out from these bronchial walls we see that the contiguous alveolar walls are similarly thickened, so that we have here a picture of bullous emphysema, bronchiectasis and some interstitial pneumonitis. Whether the bronchiectasis and the interstitial pneumonitis are responsible for the bullous emphysema or not, I do not know. I notice that you used the term "pneumatocele." I wonder whether it was justified. I have checked several textbooks to see if it is mentioned, and I cannot find it. I looked it up in the medical dictionary, and pneumatocele is defined as air in the scrotum. I wonder if you are justified in using that term.

DR. BURNETT: The dictionary also states that it is "a tumor or sac containing gas" or may refer to "a hernial protrusion of the lung tissue." I believe it is used for blebs or bullae more commonly than for scrotal gas.

DR. CHAMBERLAIN: Pathologists are bound to get us into trouble somewhere along the line. Dr. Peale, what of the element of infection here? I was a little surprised to hear of the interstitial pneumonitis, because I thought that this was one case in which the element of infection was absent.

DR. PEALE: It looks chronic. How important it is at the present time, I do not know. It looked like a chronic affair of long standing because of the marked fibrosis and the lymphocytic infiltration.

DR. BURNETT: Shall we consider H. S.?

DR. CHAMBERLAIN: I think we should, because this dramatic, excellent result is not the whole story. We still want to know what happens in cases in which the process is diffuse. Will you introduce the case of H. S. for us, Dr. Rosemond?

DR. ROSEMOND: A 55 year old Negro was admitted to the hospital with a two and a half year history of frequent colds, chronic cough and increasing and incapacitating dyspnea. He had no orthopnea and no edema of the ankles. He was perfectly well until the onset of these symptoms. On physical examination, no cardiac murmurs were heard, and the rate and rhythm were normal. There was no demonstrable cardiac enlargement. There was hyperresonance over the right apex anteriorly and posteriorly, with diminished vocal fremitus in this same region. Numerous coarse rales and wheezes were heard over both pulmonary fields. There were rather notable clubbing of the fingers and cyanosis of the finger tips.

On the patient's admission to the hospital the urine was normal. A complete blood count showed a moderate degree of polycythemia. Allergic studies showed nothing significant. Intrathoracic pressure readings were taken at the time of air aspiration, and readings on the manometer of minus 5 plus 7 were obtained throughout the removal of 600 cc. of air, the readings being taken after each 100, cc. of air was removed. The patient showed no reaction to this maneuver. However, after the completion of the thoracentesis he experienced a moderate degree of dyspnea at rest, which soon passed away.

Dr. Durant and Dr. Roesler also saw this patient. Dr. Durant has a report.

DR. DURANT: Examination at that time showed cyanosis and clubbing of fingers but no dyspnea or orthopnea. The trachea was slightly to the right. The heart was normal on examination. There were sibilant rales throughout both pulmonary fields. The upper lobe of the right lung was less resonant than that of the left. Breath sounds were diminished over the former, and no coin sounds were noted as in cases of large pneumothorax.

The remainder of the examination was entirely noncontributory. It was my impression that surgical intervention was indicated in view of the crowding of the middle and lower lobes of the right lung, as visualized by the use of "lipiodol," and I stated that it would be of interest to know what the intracystic pressure was.

DR. BURNETT: Minus 5, plus 7.

DR. CHAMBERLAIN: The roentgen appearance, when we first saw this patient on Nov. 28, 1944, was rather characteristic of a widespread type of bullous emphysema in which the greatest involvement was in the upper portion of the right lung (fig. 3 A). An interesting finding which is often seen in such cases is the caudal displacement of the hilus. You will notice that the right hilus is displaced caudad because of the large balloon cyst or emphysematous bleb or collection of blebs at the right upper portion of the pulmonary space. The lateral view shows a tracery of fine lines, which are the septums between these blebs, and the term "vanishing lung," which one hears in connection with these cases, is brought to mind by this appearance. We see where the lung is compressed in part by the expansion of the balloon cysts or blebs. The condition is pretty widespread, and this case is reminiscent of the case of J. T. that we are now considering for decision.

The bronchographic study is shown here (fig. 3 B), and the element of bronchiectasis is not at all profound. In fact, the compression of the lung and the displacements are the big features of the case. If there is any bronchiectasis present, it is of the fusiform variety. Some of these bronchi look lobulated and increased in diameter, but they are all shortened by collapse, and shortened bronchi often look a bit irregular and thickened. There is abnormal density lined up with an area that does not show anything. So there may be something hidden from us. Certainly, bronchiectasis is not the outstanding feature, but it is rather the blebs or the bullous emphysema that dominate.

Were functional tests done in this case?

DR. BURNETT: Not in this one.

DR. CHAMBERLAIN: This was earlier than our studies of pulmonary physiology.

On December 12, that is, a few days after the "lipiodol" study, pneumothorax was present, but I suppose that was produced by the needling for the determination of intracystic pressure. There is a pneumothorax here which had not been seen a few days earlier. Then, I believe it was shortly after that that you removed some of the blebs.

DR. BURNETT: Dr. Norris, bronchoscopic examination in this case was non-contributory, was it not?

DR. NORRIS: I am not sure.

DR. BURNETT: The members of the Conference decided that the patient should be subjected to operation, although, in looking back, we all wonder whether this additional amount of fibrosis and the extensive character of it make it worth while. Certainly, there was a great displacement of these big ballooned-out cavities which Dr. Chamberlain called to your attention. We did operate on him shortly after

these studies which have been demonstrated. There was a considerable degree of emphysema of the entire right lung, ranging from small dilated vesicles to large bullae, the largest of which measured about 8 by 10 cm. The majority were in the apex of the upper lobe and involved about a third of this lobe. There was another large bulla, making a thin-walled balloon measuring about 7 by 5 cm., of the middle lobe, and this was removed first. The remaining part of the lung contained small emphysematous blebs visible rather generally.

There was considerable pigmentation of the lungs, and in the apical portion there were little calcified nodules, suggesting old tuberculosis. There were multiple adhesions around the apex and a few posteriorly, but they were soft and old and easily separated. The anatomy otherwise was normal.

The follow-up study of this man covers a little over three years. He states that his shortness of breath is much more notable than it was before the operation. We heard from him once before and felt that he had improved slightly but not dramatically by any means. Now, he is retrogressing. He has been unable to hold a job for any long period; he worked about two weeks and then had to rest for two or three weeks because of his physical condition, and in the past year he has not worked at all.

The physical examination showed an emphysematous chest over which the breath sounds were barely audible, and he pulls his larynx down about an inch (2.5 cm.) each time he inspires. He has chronic cough and whitish sputum, and this has persisted since before the operation.

Dr. Oppenheimer has the results of a study of pulmonary function done on this patient as a follow-up procedure, though we did not have such a study before operation. Will you give us the data, Dr. Oppenheimer?

DR. OPPENHEIMER: I think that it will not be necessary to read the detailed figures, but I believe the summary is important, especially for the bronchspirometric study, which demonstrates conclusively that now the right lung is providing 72 per cent of the total oxygen consumption and functions with more than twice the efficiency of the left. The ventilatory capacity of the two lungs is about equal.

DR. CHAMBERLAIN: It was the right lung, Dr. Burnett, which you worked on. That is reassuring.

DR. BURNETT: We realize that this is a progressive malady, and, unless we can remove the cause, the question is whether the palliation which we can offer is of sufficient value to the patients. That is what I wanted the Conference to consider today. Apparently, this man might have been a good deal worse off had he not had the surgical treatment, since in some of the few severe cases we have been unable to deal with the condition at all and have seen the patients choke to death gradually from progression of disease.

DR. CHAMBERLAIN: I am particularly interested in those spirometric studies because it is seen that the roentgenologic appearance has improved tremendously as a result of the operation (fig. 3 C). I was a little disappointed to hear that the man is not able to work steadily and that he has great respiratory difficulty, because certainly the drooping of the right hilus and the compression of the right lung by the large air-filled spaces that were present before the operation have disappeared entirely, and a good appearance is seen in the roentgenograms made a few days ago at the time of the spirometric study.

DR. BURNETT: This man's disease might have progressed much more rapidly had he not had the increased capacity which was given by surgical intervention.

DR. CHAMBERLAIN: Was there anything significant in the surgical specimens in the case of H. S., Dr. Peale?

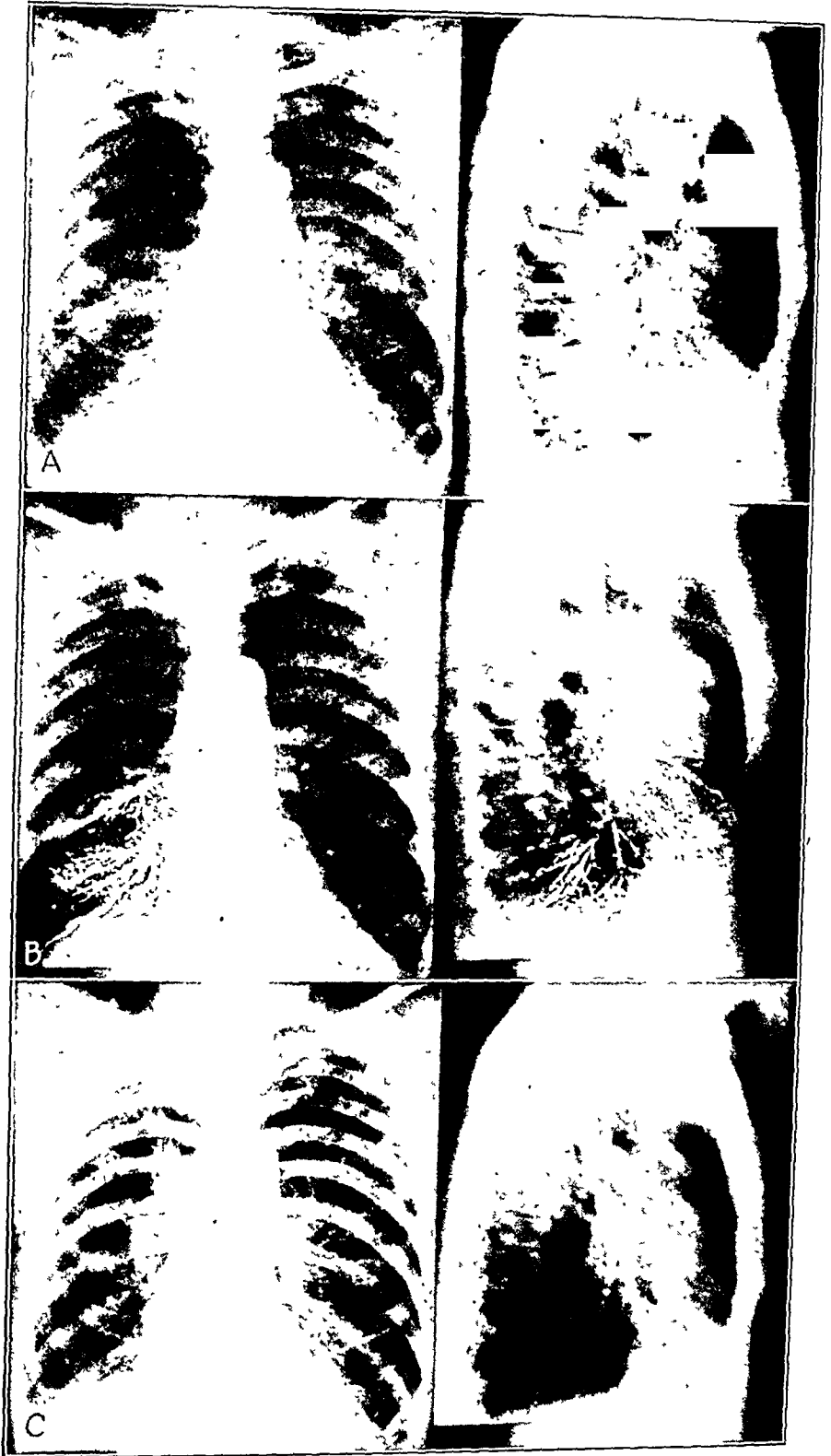


Figure 3

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DR. PEALE: No. Your point on the bronchiectasis is true; we found nothing. The only comment I should like to make is that there was tremendous scarring.

DR. CHAMBERLAIN: Fibrosis of the lung?

DR. PEALE: Yes.

DR. CHAMBERLAIN: Was it a diffuse interstitial fibrosis?

DR. PEALE: Yes, it was. Of course, we saw it only in one section.

DR. CHAMBERLAIN: We call it nonspecific because we see it in all sorts of conditions. Dr. Burnett, I think, feels that it may have been a factor in the difficulty which the man is now having, and I should think so, because many patients, without having had emphysematous blebs and without having undergone an operation, are really functionally disturbed to a pronounced degree by pulmonary fibrosis. That was found in the operative specimen and is obvious on the original and on the present roentgenograms, but mechanically it looks as though a great improvement had been made in the right lung by the surgical treatment.

Yet, according to the studies of respiratory physiology, the left lung is much worse off than the right, and in the left we have nothing to remove surgically. We have a problem. Do you think it might be advisable, Dr. Burnett, in view of the fact that he is doing so well with his right lung, to bring this man back for "lipiodol" bronchographic study and mapping of his left side? He may have more bronchiectasis on the left than we realize, and we might even find that we could benefit him further by treating it if it is present.

DR. BURNETT: That is possible. I should think, though, that it would be most unwise to remove any pulmonary structure as long as he does not show any gross degree of infection and the sputum does not indicate it at present, although we have not had a culture. What we have been considering since we had this follow-up report is whether or not autonomic denervation might be of some value to him. He is a poor risk for any surgical treatment in his present state.

DR. CHAMBERLAIN: Is he asthmatic?

DR. BURNETT: He seems to be extremely uncomfortable; even when he is sitting still, he leans forward to breathe, and he is using accessory muscles all the time to a mild degree. He is not at all a good risk, and I am sure that we can offer him little.

DR. GINSBURG: May I ask whether there is much of a bronchospastic element now?

DR. BURNETT: We do not hear whistling or wheezing at present, Dr. Ginsburg. He has no spasmodic attacks.

Fig. 3 (case 3, H. S.).—A, Nov. 28, 1944. Collection of large blebs in the region of the upper lobe of the right lung, displacing the lung, including the hilus. Note also the evidence of a large number of small blebs, diffusely distributed throughout the right lung. B, Dec. 6, 1944. "Lipiodol" bronchograms. Some of the bronchi appear widened, but there is no evidence of sacular bronchiectasis. The principal finding is the compression of the lung and the displacement of the bronchi. C, Oct. 21, 1947. Follow-up roentgenograms taken approximately three years after surgical extirpation of the large blebs in the upper and middle lobes of right lung. At the time of this follow-up visit studies of respiratory function, including bronchspirometric study, showed the right lung to be functioning twice as efficiently as the left. Yet the roentgenologic findings indicate persistence of the many small blebs diffusely distributed throughout the right lung, with the left pulmonary field comparatively normal in appearance. The impaired function of the left lung may be due to fibrosis (note prominent markings), bronchiectasis (note abnormal density at left base) and emphysema (note caudal displacement of left leaf of diaphragm).

DR. GINSBURG: Is there any indication from the roentgenograms that the left lung might have less function than the right?

DR. CHAMBERLAIN: Not at all. I am as surprised as anybody in the Conference to hear the bronchspirometric data. It is the second case in succession in which the roentgen findings did not give an indication of the relative function of the two lungs.

DR. OPPENHEIMER: Dr. Chamberlain, does this illustrate Max Pinner's point that if the pleura is not extensively involved one can have good pulmonary function, even though the roentgenographic appearance of the parenchyma is bad?

DR. CHAMBERLAIN: Well, perhaps it does.

DR. COHEN: He has pleurisy at the left base, which would fit in with the poor function of his left lung.

DR. CHAMBERLAIN: Yes, but does it really fit in? Does the pleurisy of the base only interfere with the function? It is really the pleura around the outside of the lung—the rind on the orange—that counts, is it not?

DR. COHEN: In pulmonary tuberculosis the practical application of pulmonary functional study is to demonstrate that the contralateral lung, which looks healthy on roentgenologic study, really does have good function. We sometimes obtain data showing poor function in this lung.

DR. GINSBURG: Do you think that there might be any indication that there is a shift to the right in the cardiac silhouette in the interim between roentgenologic studies?

DR. CHAMBERLAIN: We can easily tell that by putting the original roentgenogram next to the most recent one (fig. 3 C), because in both cases the centering is good. The medial ends of the clavicles are matched with the spinous processes, and I think we can say that the heart is a little to the right now as compared with the former position.

DR. GINSBURG: Dr. Burnett, are you surprised that in these cases we have not found any bronchiolar stenosis as a cause for the pulmonary changes?

DR. CHAMBERLAIN: In other words, the pathologist has not described a bronchiolar stenosis in these cases.

DR. BURNETT: The pathologist has not had an opportunity to see that really, because all we have removed from these patients so far has been extrabronchial material, simply the broken-down alveoli or the subpleural bleb. So we cannot say that there is no bronchial stenosis. We have seen bronchial openings, naturally, and have tried to occlude them, but we have not removed pieces of bronchus or bronchioles for the pathologist to see.

DR. GINSBURG: I mention this because of Dr. Amberson's demonstration. I wondered if we had been able to show anything significant in these cases.

DR. CHAMBERLAIN: Dr. Rosemond, will you introduce for us the case of L. M.?

DR. ROSEMOND: L. M., a 51 year old white woman, was admitted to the hospital with a history of having been perfectly well until seven months before. While riding in an airplane, she experienced a sudden sharp pain in the left side of the chest, followed by rather pronounced dyspnea. The dyspnea continued for a short while after she returned to the ground and then cleared completely. Since that time, she has had several similar experiences, without flying, recurring as often as every two or three weeks. She has had sharp pain in her chest followed by dyspnea with all these attacks. She has been under treatment for this by her local physician. There has been no edema of the ankles.

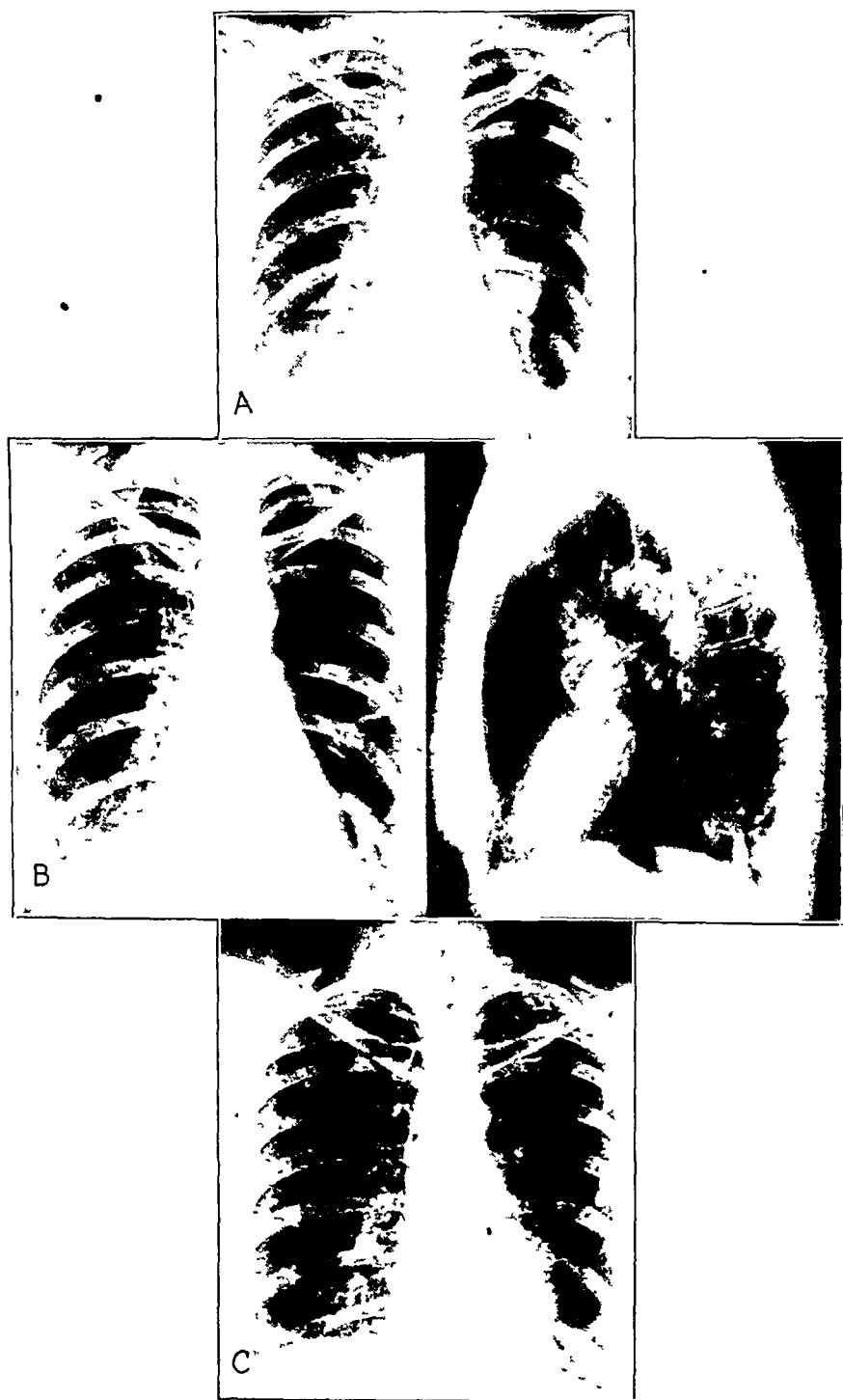


Fig. 4 (case 4, L. McN.).—*A*, Oct. 11, 1946. Massive spontaneous pneumothorax on the left, incurred in the course of an airplane flight. *B*, Feb. 7, 1947. Pneumothorax still present but with sufficient reexpansion of left lung to show the presence of bullous emphysema. *C*, Oct. 7, 1947. Ventral projection approximately eight months after surgical extirpation of blebs. The roentgenologic appearance is essentially normal.

Physical examination revealed a well developed 51 year old white woman in moderate respiratory distress while lying in bed. The heart sounds were distant. There were no murmurs. The rate and rhythm were normal. There was bilateral hyperresonance, more marked on the left side. There was a suggestion of a lag on the left. There were no rales, and the breath sounds over the left side of the chest were diminished. There was no clubbing or cyanosis of the finger tips. On her admission, the blood count and the urine were normal.

DR. CHAMBERLAIN: The original studies, in October 1946 (fig. 4 A) showed just the pneumothorax with the compressed left lung and some displacement of the mediastinum toward the right. There was no evident disease on the right except for some congestion and prominence of pulmonary vessels.

Then, in February 1947 (fig. 4 B), as the lung expanded with the gradual disappearance of the pneumothorax, fine lines showed up in the lung that are, of course, characteristic of bullous emphysema. The outlining of the aorta coursing along through the area of the pneumothorax is interesting. One does not often get an aortic shadow like that.

The next roentgenograms which I have after February 7 were taken after surgical intervention, so I think that we had better ask for further information regarding this case.

DR. BURNETT: Dr. Oppenheimer, will you give the results of the functional studies at the time in February when there was partial reexpansion of the lung after the pneumothorax?

DR. OPPENHEIMER: We have only the results of external spirometric studies, Dr. Burnett. The efficiency of respiration as measured by the ventilation equivalent is normal, but the reserve capacity is well below normal limits as determined according to a series that Dr. Burnett has collected for us. The reserve capacity is only 72 per cent. We feel that it should be at least 75 per cent or above.

DR. BURNETT: This illustrated to us another type of event associated with these emphysematous blebs or bullae, in which repeated rupture occurs and pneumothorax results. As Dr. Chamberlain pointed out, the only cystic area of much size was not a large one, possibly 5 by 7 cm. at the most, although there were others of smaller size in that vicinity. But the patient had these repeated episodes of pneumothorax; so the members of the Conference felt that she should be operated on. She was subjected to surgical treatment and this small cyst removed. Incidentally, it was found to have a few adhesions which apparently helped to break it open, or to tear it open. They were rather strong ones, three of them, leading up to the thoracic wall and under tension when we opened the chest. So possibly they contributed to this repeated rupture, although we admit that they could have resulted from the original rupture. After removal, the lung reexpanded rather readily.

There was a middle lobe also on this left side, indicating a congenital anomaly possibly associated with this formation.

DR. HUBER: It is rather common to have an extra fissure there, so I would not attach any significance to it.

DR. CHAMBERLAIN: I knew Dr. Huber would say that, because he has shown us a great many of these middle lobes on the left side.

DR. BURNETT: We have seen a few of them at operation also but not enough to think it is common.

DR. HUBER: There is some representation of a fissure in close to 50 per cent of cases—some indication of representation of the fissure between the superior and the inferior division.

DR. BURNETT: We have a follow-up report on this patient covering a period of about six months (fig. 4 C). She had gained somewhat in weight, about 3 pounds (1.3 Kg.). She complained only of weakness. She looks well and is able to walk upstairs without breathlessness and to conduct all her normal activities in comfortable fashion. Pneumothorax has not recurred.

The physical examination showed a well healed inframammary scar. There is no evidence of collapse of the left lung; it seems well expanded, and breath sounds are heard, although softly, throughout the left side of the chest. There is no lag. There is good expansion on both sides. Percussion is clear throughout. Her general appearance is good, and we consider the result exceedingly satisfactory.

DR. CHAMBERLAIN: Some of us like to fly, and we are interested in the fact that pneumothorax developed in this woman as a result of an airplane trip. If she had a blocked air-containing space, an emphysematous bleb that temporarily had no orifice, it might have something to do with the rupture because air-filled spaces certainly do enlarge remarkably during increase of altitude. A bowel with some gas in it, for instance, can cause acute pain. I have seen army fliers in the artificial altitude chamber experience severe pain in the abdomen as a result of having some gas in the colon. It is amazing what will happen to gas-containing spaces at high altitude. Ordinarily, a space that connects freely with the bronchial system should not be under any strain as a result of altitude.

DR. PEALE: There was nothing significant found in the pathologic examination except that the walls in some of these cysts were thick and mucilaginous, with patchy areas of calcification.

DR. CHAMBERLAIN: That is interesting. We do not see any evidence of patchy areas of calcification in our roentgenogram.

DR. PEALE: Microscopic.

DR. CHAMBERLAIN: The outcome in this case is extremely good, indeed. Now I should like to call for the report on Mr. F. S., from whose case we learned so much about the condition of bullous emphysema.

DR. BURNETT: Dr. Chamberlain, may I add one thing? I cannot find the record of it here, but there was a follow-up external spirometric study of Mrs. L. M. which showed a 74 per cent reserve capacity, and the note was made by the examiner who did this particular test that the patient was excited and not actually in a basal state so that her reserve is probably higher than 74 per cent. At least it is two points higher than it was before she was operated on, and clinically she seems a great deal better, which suggests that the observation was correct that there was more spread between basal and forced breathing than was put on the report.

DR. CHAMBERLAIN: As we are now considering bullous emphysema or emphysematous blebs, I should like to have a review of the case of F. S. Dr. Rosemond will introduce this case, brought to us by Dr. Cohen before we knew much about the condition.

DR. ROSEMOND: F. S., a 30 year old white man, was admitted to the hospital with a history of increasing dyspnea on exertion for three years, until it was incapacitating, and of an increasing amount of chronic cough which recently had become productive. The cough was accompanied with pain in the right side of the chest. There was no hemoptysis or night sweats and no known tuberculous contact. Six months prior to admission, he had a bilateral Caldwell-Luc operation, with some alleviation of his cough.

His personal history was noncontributory in relation to the present illness. Physical examination revealed a fairly well developed white man who was in no great degree of respiratory embarrassment while lying in bed. There was hyperresonance over the entire right side of the chest and anteriorly over the mediastinum. The remainder of the pulmonary fields was normal. Over the tympanic area vocal fremitus was decreased and breath sounds were absent.

There was no clubbing or cyanosis of the finger tips and no edema of the ankles. Numerous readings within the cyst cavity showed an initial pressure of plus 2 to

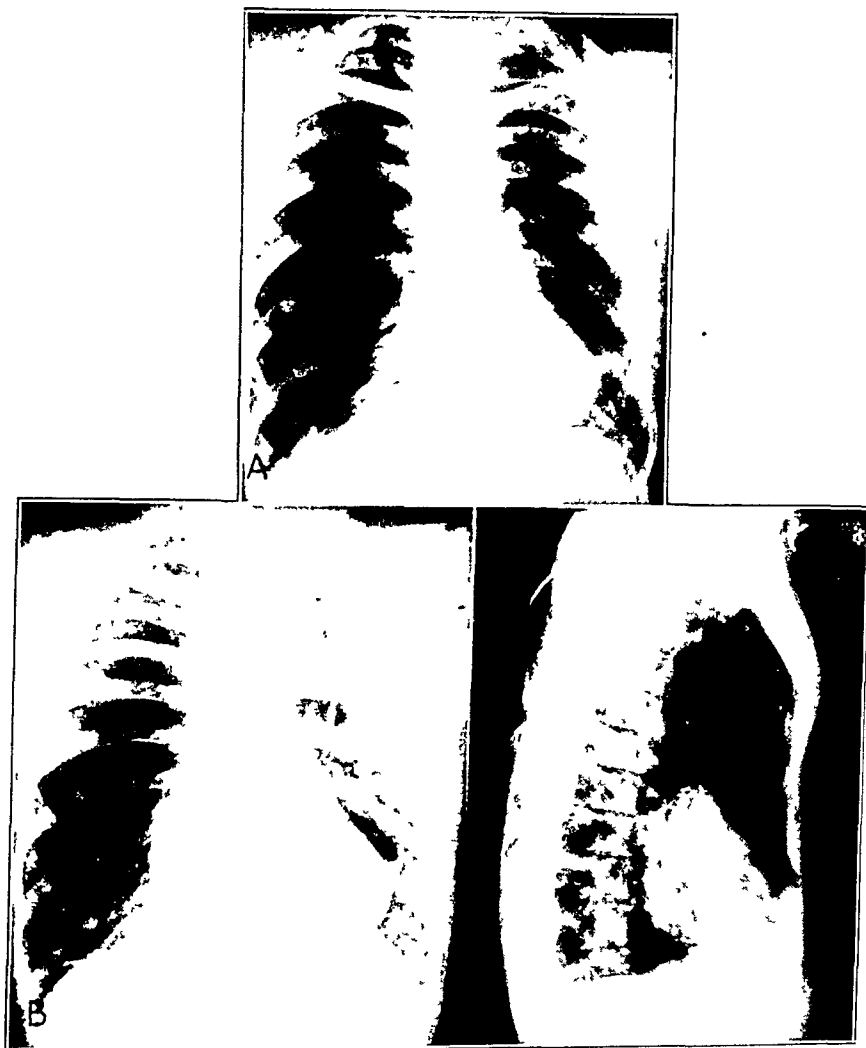


Fig. 5 (case 5, F. S.).—*A*, Jan. 19, 1943. A most remarkable case of balloon cysts (bullous emphysema) in which the compressed and almost airless right lung is seen in the region normally occupied by the vena cava. *B*, Jan. 21, 1943. "Lipiodol" introduced through a thoracentesis needle has accentuated the veil-like, membranous septums which divide the various blebs from each other. Note the pronounced mediastinal herniation, with mediastinal layers of pleura displaced far over toward the left axilla.

minus 4, and on deep inspiration this was reduced to zero minus 14. Then 250 cc. of air was removed, with the resulting pressures: normal breathing, plus 2 minus 6; deep inspiration, zero minus 20.

The blood count and the urine were normal and repeated examinations of the sputum revealed no acid-fast rods. The urine was also examined for evidence of acid-fast rods, and they were not found. Examination of the heart, including electrocardiographic study, showed it to be normal.

DR. CHAMBERLAIN: At the first examination (demonstrating roentgenograms) we see an almost complete absence of detail in the right pulmonary field, which led us to a diagnosis of pneumothorax. Note this "ballooning" over, through the anterior mediastinum toward the left side (fig. 5). The left border of this structure, which turned out to be a huge balloon cyst, is over against the left ribs (fig. 5 A).

After Dr. Cohen had carried out considerable aspiration, to decompress this from positive pressure to negative pressure, we finally got this margin of one of the large cysts to move over so that it can be seen in the left pulmonary field (fig. 5 B). It is over against the left rib cage in the first study.

The January 1943 planigraphic studies showed some lung down in the region of the cardiohepatic angle at the right base, with the layers of mediastinal pleura close to the left axillary ribs. I think this is a rather dramatic demonstration of mediastinal herniation. This is part of one of the big cysts of the right lung over in the left side of the thorax through the mediastinal hernia.

Now, I should like to hear from Dr. Cohen regarding his interesting findings in relation to the pneumothorax pressure readings.

DR. COHEN: This patient came into the office, or was brought into the office, in critical condition because of dyspnea, cyanosis and pain in the right side of the chest. He had roentgenograms with him, taken eighteen months previously, showing almost the same condition. There was a complete absence of lung in the right side of the thorax. It looked like an ordinary spontaneous pneumothorax, and I thought it was and immediately carried out aspiration for decompression. I was greatly surprised when, after great quantities of air, probably 2,000 cc. had been taken out, the patient felt worse and was just the reverse of what we expect after aspiration for spontaneous pneumothorax. In fact, he experienced such great pain that I was alarmed.

One of the interesting factors was that the patient was so sick that after study in the Chest Conference and aspiration of air and preparation for possible surgical intervention, it was questionable whether he could stand surgical procedure. I thought he could not and Dr. Long, who was interested in studies of pulmonary function, persuaded him to have the operation. He slept sitting on a chair with his head on the bed. That is how dyspneic he was.

We introduced some "lipiodol" into the cavity, which gave us further evidence of the presence of a cyst.

DR. CHAMBERLAIN: Dr. Burnett, will you tell us about the operative findings in this case?

DR. BURNETT: Yes. Major difficulty was experienced in putting this patient under anesthesia, and he was so dyspneic that it was a problem. Our anesthetist, Dr. Woodbridge, had a great deal of difficulty. Although he slipped the intratracheal tube in rapidly, as usual, the patient became cyanotic before the tube was in deep enough to be used. We were frightened for a moment or two about his survival. After that, there was little difficulty. Apparently the readings of the intracystic pressure had produced pneumothorax, so we found a rather extensive one when we opened the chest and a small amount, 300 or 400 cc. of slightly turbid, grayish fluid. The lung was completely collapsed; the cyst was partly collapsed, and the mediastinal herniation was not so great as demonstrated on some of the

earlier roentgenograms. It measured 12 to 15 cm. from the caudal to the cephalic end and about 3 to 4 cm. anteroposteriorly. The bleb was a tremendous one with an extremely thin wall, so that the mere attempt to handle it tore it into small shreds and sheets and there was little to send to the laboratory, although we excised it completely. The herniation extended about 15 cm. across from the midline into the left side of the chest. There were no adhesions over there, and the extrusion was easily withdrawn.

An interesting fact was that there was a small pedicle, only 2 to 3 cm. in size, with two small vessels and one bronchial opening. It required actually one hemostat's length to encompass the whole area, after which the lung was expanded by gentle positive pressure and rapidly came to full expansion without any difficulty. It was normal in appearance in its other areas, except for one immediately adjacent small bulla about 2 cm. in diameter, which we took out. I do not believe that the needle was in that small one, which was rather inaccessible. I think it was in the large one, and the "lipiodol" which was inserted is shown along the trabeculae within the fibrous irregular wall of the broken-down alveoli.

DR. COHEN: The surprising thing to me, Dr. Chamberlain, was that we had roentgenograms which were taken eighteen months prior to this, and it was apparent that the condition was present all this time, with complete compression of the right lung, and still the lung was not carnified. It was healthy looking and expanded rather easily (fig. 6 A).

DR. CHAMBERLAIN: I think that is something which we can put down in the record to remember, because it indicates, does it not, that there can be a prolonged compression of a lung without the loss of its function or ability to reexpand, provided the element of infection is absent.

DR. COHEN: You mean complete compression?

DR. CHAMBERLAIN: Yes.

DR. BURNETT: If there is no fibrosis or bronchial blockage, it has been our experience that the lung will rapidly expand. We have a five year follow-up report on this patient, who was seen within the month. He states that he is greatly improved. He notices no abnormal breathlessness. In other words, he has normal breathing capacity as far as can be determined and has no complaint except that all the symptoms referable to the sinusitis for which he has been treated are still present.

Examination of his chest revealed no abnormality of the lungs or of the diaphragmatic movement, and his average weight is now 130 pounds (59 Kg.). It was 90 pounds (40.8 Kg.) previous to operation.

We have results of follow-up external, spirometric and bronchspirometric study, although such study was not made preoperatively. May we have data, Dr. Oppenheimer?

DR. OPPENHEIMER: For external spirometry, the efficiency of respiration is normal as shown by the low ventilation equivalent, which was 1.9, from 1 to 3 being normal. Maximum breathing capacity is low, being 16 liters, and for a man of his size the level ought to go up to 100 liters at any rate. The patient shows good ability to increase the depth of respiration above the resting level, which probably accounts for his lack of dyspnea on exertion. He had a vital capacity of 2,000 cc.

Bronchspirometric study indicates a normal distribution of oxygen consumption between the two lungs. The right lung functions more efficiently than the left. The ventilation equivalent on the right is 1.4 and on the left 4.0; however, the left lung has greater capacity for ventilation, providing 60 per cent of the maximum breathing capacity.

DR. CHAMBERLAIN: That is interesting indeed.

I just want to point to the most recent roentgenograms, taken a few days ago for follow-up study (fig. 6 *B*). They show a good pair of lungs and are in keeping with what you have just heard. One can find a couple of thin lines at the right apex, suggesting that there might be one or two little emphysematous blebs up there where the excision was done but nothing important and nothing to interfere with pulmonary function.

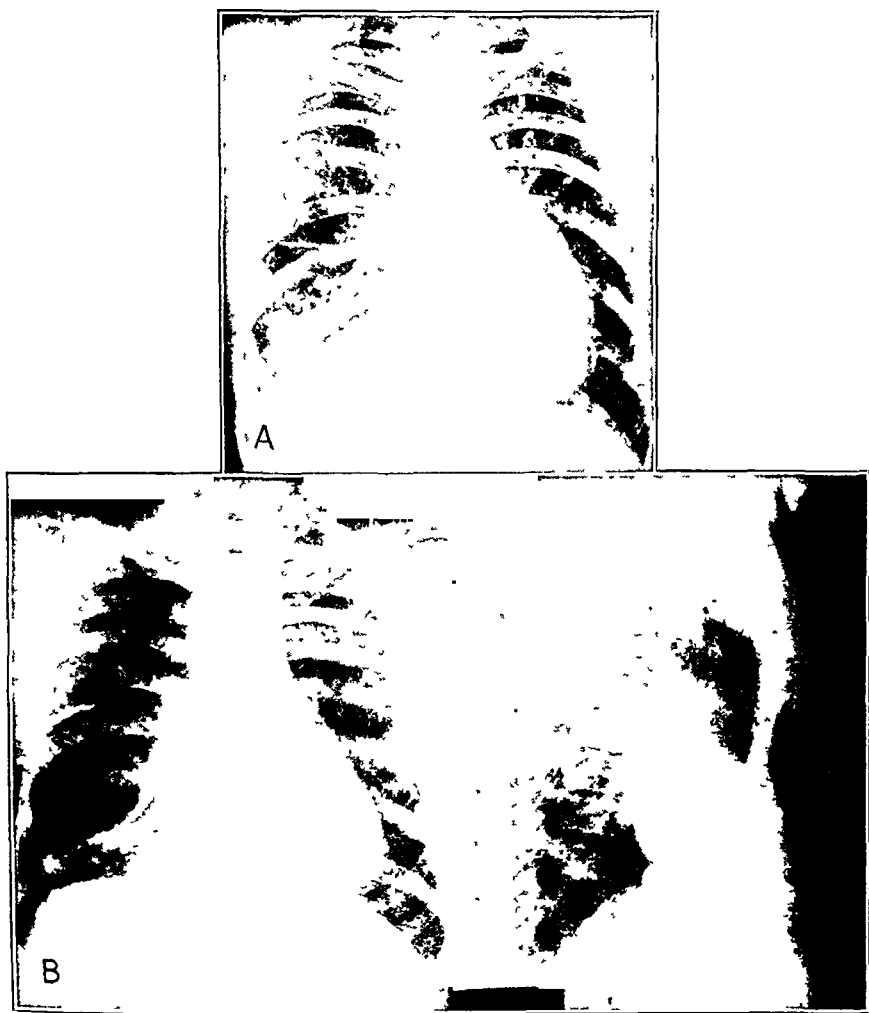


Fig. 6 (case 5, F. S.).—*A*, March 4, 1943. Appearance three weeks after surgical extirpation of large balloon cysts by division of the "pedicle" by which they were attached to the apex of the right lung. Reexpansion of the long-compressed right lung was prompt, being accomplished under observation during the operation. *B*, Oct. 20, 1947. Follow-up roentgenograms taken four and a half years after surgical removal of balloon cysts. Except for unimportant scars of the right lung and the rib cage, the roentgen appearance is normal. The patient is clinically well.

About the only abnormality that is obvious is the fact that the surgeon has operated on that area. There is a rib scar in this particular case because of the different kind of incision.

I think we now ought to consider J. T. again. We have reviewed the other cases, and I should like to get the Conference to express an opinion with regard to the current case that is up for decision. Personally, Dr. Burnett, I should like to go on record as not being in favor of surgical intervention in the case of J. T., on the ground that the disease is widespread throughout the lung and is not concentrated in any particular area to the point where we would expect you to accomplish much. However, you might improve the situation somewhat if you could take out anything that occupies as much space as the bleb here, the bleb there and this bleb in the region of the middle lobe shown in the lateral views (pointing to figure 1). This last may not be in the middle lobe at all; it may be in the left lung.

Dr. Cohen, what is your opinion in regard to therapy?

DR. COHEN: We had a patient named A. L. who had something similar to this, not so circumscribed but generalized. I do not believe he did so well. I am a little bit afraid of surgical intervention in this case, especially with a pulmonary reserve of 38 per cent. It is an extremely low reserve. So I do not think you would get a good result in this case with surgical treatment unless you could remove some infection or bronchiectasis.

DR. CHAMBERLAIN: Dr. Oppenheimer, would you be willing to express an opinion on whether this patient could undergo surgical treatment?

DR. OPPENHEIMER: While the reserve is low, Dr. Burnett has continually astounded us by operating on patients with values below that which we have considered normal. As a matter of fact, we frequently have had to reduce the minimal level which is considered safe because the surgeons have continued to show us that one could go below the published figures. This is low, however.

DR. BURNETT: I might mention the fact that there have been 7 additional cases of this type in which operation has been performed, with five good results, one fair result and one poor result, of which Dr. Cohen spoke a moment ago (Mr. A. L.). Incidentally, Mr. A. L. was reoperated on because of what appeared to be a persisting cyst, but it proved to be an organized hemothorax overlying an endothelioma of the pleura. Those are the reasons for persistent trouble. That was about a year after his original operation. He is still in the hospital after his second exploration and is receiving roentgen ray therapy for his malignant tumor.

I think we can help those patients who have a large but localized area of involvement, but this patient does not seem to be of that type. It seems to me that probably the three small areas shown on the right, with more function on the right than on the left as shown by bronchspirometric study, are not interfering greatly with his health. None of those areas measured over about 10 by 6 cm.

DR. CHAMBERLAIN: Something like that.

DR. BURNETT: That is the largest one, and there are three visible on one side or the other as well as generalized small ones. He has improved a good deal on the present conservative therapy, and I think it might be well to persist in this.

The thing that appealed to me most about operating on this man was the possibility of denervation and consequent decrease in the bronchospasm, which is probably the cause of most of the trouble. Although he has not had a history of asthma, he did respond at first to bronchial dilators, and most of the studies that have been made on these patients have demonstrated bronchospasm in some degree. I think that if we ever decide to operate on him, the decision would probably have as its basic motive the desire to denervate the lungs rather than to excise the cysts. I would agree with the more conservative view. What do you think, Dr. Rosemond?

DR. ROSEMOND: The patient has improved. I think we should withhold surgical treatment. I was also thinking of the possibility of denervation. I would be inclined to leave as much of the lung as possible in this patient. There might be some large, easily accessible cyst which could be easily removed, but I do not think that he would be able to stand extensive surgical procedure. I do think his condition ought to be reevaluated now because he has improved and the pulmonary function might be a great deal better at the present time than it was eight months ago.

DR. CHAMBERLAIN: Dr. Ginsburg, the department of internal medicine should express an opinion on this point.

DR. GINSBURG: Dr. Burnett has studied a number of these cases and has operated in some in which there was greatly reduced pulmonary function, with improvement in most instances. It appears that this patient has a decreased amount of sputum now and less bronchospasm, as evidenced by wheezing, probably because of the decreased infection in the pulmonary field. We often find that cough alone will cause spasm. If that has been reduced, the sputum decreased and the cough relieved, he may be improved for a long time without surgical intervention.

I think Dr. Rosemond suggested reevaluation now that the infection at least appears to have been controlled.

DR. WESTON: Will you tell us briefly what the denervation procedure is?

DR. BURNETT: Two have been recommended. Rienhoff has reported¹ several instances of denervation of the posterior pulmonary plexus, which includes vagus and sympathetic fibers. He reported 21 cases five years ago in which there had been considerable improvement in 3, moderate improvement in 5 and no improvement in 13.

More recently, Duane Carr,² at the meeting of the Association for Thoracic Surgery, suggested removal of the second, third, fourth and fifth thoracic sympathetic ganglions on each side through a small posterior incision, which is a much less extensive procedure than dissection of the pulmonary plexus in cases in which the volume is low. He was using it for treatment of asthma. Osler Abbott,³ in discussion, said that he had applied the procedure in a few cases of pulmonary emphysema and thought it was worth while. This seems illôgical from a physiologic viewpoint. Both maneuvers are of questionable value, but we are treating a disease which is frequently fatal.

To summarize, then, the cause of this condition is not well known, but both logic and the general opinion are behind the thought that there is definitely increased intrabronchiolar pressure which can be contributed to by bronchospasm, allergy and infection singly or together. That there is a check valve mechanism in many cases, causing extreme ballooning and the tremendous size which is sometimes seen, is undeniable. Certainly allergy can play a part and should be investigated in each instance.

Two items in the pathologic process should be stressed. One is that there is usually more extensive disease than can be demonstrated by roentgenologic study and the other that there is a progression of the disease unless the cause

1. Rienhoff, W. M., and Gay, L. N.: *Further Observations on Treatment of Intractable Bronchial Asthma by Bilateral Resection of Pulmonary Plexus*, J. Allergy **13**:626-631, 1942.

2. Carr, D.: Personal communication to the author.

3. Abbott, O. A.: Personal communication to the author.

can be found and abolished. This means that treatment usually is palliative rather than curative. Unless the cause can be abolished, there is a gradually increasing diminution in the ventilatory capacity and of absorptive surfaces so that anoxia develops and progresses until a horrible death by asphyxia occurs. Palliation can delay this end for variable periods. A severe degree of anoxia was noted in some of the patients discussed, and a few others for whom palliation could not be attempted because of the extreme degree of the pathologic changes have progressed to such a miserable ending.

It is understandable, therefore, that we are interested in doing all things which can delay or possibly arrest the process and consider even procedures which are not too well accepted. Ideally, the treatment should follow the usual principle of eliminating the cause and ridding the patient also of the pathologic changes caused by the etiologic factor while active. Neither of these is usually susceptible of complete accomplishment, but we should bend every effort toward elimination of infection, of bronchospasm and of allergy. This objective is best accomplished by inhalation of antibiotics of an appropriate nature, with wetting agents for more rapid penetration or at times bronchial relaxants such as epinephrine hydrochloride in the more extreme cases of bronchospasm. A thorough allergic study, with avoidance of allergens as indicated and desensitization as far as possible, is of considerable importance. These measures can lead to great improvement clinically and to partial or even complete arrest of the progression. Associated treatment of the congestive heart failure which often develops from the *cor pulmonale* may aid considerably.

Since palliation is usually of vital importance, surgical intervention has a definite but limited place. Certainly diffuse generalized break-down of alveolar structure, with the areas measuring from a few millimeters to 4 or 5 cm. in size, cannot be helped by excision, but may be delayed or arrested by neurectomy of the vagal influence or, paradoxically, by the more limited risk of sympathetic ganglionectomy as applied with some success by Carr and Abbott on the hypothesis that congestion of the mucous membrane and viscid secretion rather than bronchospasm may be causative and that interruption of the sympathetic nerves may decrease this feature.² These procedures, however, are of questionable value and are still under observation for their empiric effect.

When the greater part of the lesion is localized in a lobe or part of a lobe and is large, measuring 15 cm. or more, great benefit can result from excision, which permits reexpansion of collapsed functional respiratory tissue and thereby greatly improves the respiratory reserve. Several of the patients discussed had such localized lesions, which in two instances occupied the entire hemithorax and extended across the mediastinum to invade the opposite side. The remainder of the lungs in these instances showed little impairment, and tremendous advantage was obtained by excising the pedunculated ballooned cysts or bullae. The improvement justifies the risk of thoracotomy, and it is possible that a simpler method of deflating and eradicating the bullae can be developed.⁴

A few of the patients in this series have been clinically cured, several others have been greatly improved although there is still some disease and some functional impairment, and 2 have shown little or no improvement, although functional study reveals that the lung operated on is functioning better than

4. At the Quebec meeting of the American Association for Thoracic Surgery Dr. Jerome Head and his associates presented several cases in which patients were apparently cured of large and medium-sized bullae by the simple maneuver of prolonged intercavity drainage.

the opposite one since the operation was done. External spirometric and broncho-spirometric study has been utilized in the more recent cases for more graphic demonstration of the results observed clinically, and the results correspond to the statements made. Low preoperative functional tests, if not too extreme, may indicate rather than contraindicate palliative surgical procedure, since function should be immediately improved by reexpanding the collapsed useful pulmonary tissue.

We have reserved lobectomy for those patients with truly intrapulmonary cysts of a congenital nature in which infection so frequently supervenes. In the cases in which bullae have been present it has not been necessary to do lobectomy but only excision of the area involved, conserving the remaining useful lung. In some instances several bullae were removed, in 1 case from all three of the lobes on the right.

The condition should be suspected in any case in which the presenting symptom is dyspnea, in which repeated episodes of spontaneous pneumothorax occur or in which emphysema is found on physical examination. Large bullae are often mistaken for pneumothorax even on roentgenologic study. Roentgenography is usually diagnostic, demonstrating rarified areas, "vanishing lung," fine trabeculations in the cavity and, in severe cases, compressed lung, displaced mediastinum, drooping of the hilus and even mediastinal herniation. Intracavitary pressure readings contribute no diagnostic aid and are frequently harmful. They often add the additional dysfunction of pneumothorax to the symptoms of an already distressed patient when the extremely thin wall is torn. I see no reason for their continued use.

The condition of the patient under consideration, then, will be reevaluated and presented to the Conference again at a future time for further consideration. He does not seem to be a good candidate for surgical intervention, since his disease is rather generalized and there are no localized huge dilated areas which could be excised.

DR. CHAMBERLAIN: Since it is late, there is insufficient time to take up other cases. The Conference is adjourned.

PROGRESS IN ORTHOPEDIC SURGERY FOR 1946

A Review Prepared by an Editorial Board of the American Academy
of Orthopaedic Surgeons

XI. CONDITIONS INVOLVING THE LOWER PART OF THE BACK

Prepared by

R. BEVERLY RANEY, M.D., DURHAM, N. C.

Introduction.—In 1947 a discussion of ruptured intervertebral disks and sciatic pain was prefaced by Barr⁴¹⁴ with the following introduction: "As students of the defects and diseases of the human frame, we are daily reminded that the truth is hard to come by, and that our knowledge of any medical subject is incomplete, defective, and capable of continually being increased." I know of no statement which might be applied more pertinently to the 1946 literature on conditions involving the lower part of the back. Although these writings were voluminous, few original concepts or techniques were introduced and little unanimity concerning pathogenesis or treatment was apparent. Accordingly, and for the sake of brevity, many articles have simply been cited in this review, while most of the more significant contributions have been briefly abstracted. References to several foreign articles published prior to 1946 but not previously available for abstracting have been included.

Pain in the Lower Part of the Back.—The importance of pain in the lower part of the back in the practice of medicine calls forth each year a number of articles discussing in more or less general terms its differential diagnosis and treatment. Papers of this type have been published by Bankart,⁴¹⁵ Rizzo,⁴¹⁶ Hudson,⁴¹⁷ Torrance,⁴¹⁸ Walter,⁴¹⁹ Stewart,⁴²⁰ Lee,⁴²¹ and Larochelle.⁴²² A detailed routine for standard-

414. Barr, J. S.: Ruptured Intervertebral Disc and Sciatic Pain, *J. Bone & Joint Surg.* **29**:429-437 (April) 1947.

415. Bankart, A. S. B.: Low Back Pain and Sciatica, *Practitioner* **157**:367-371 (Nov.) 1946.

416. Rizzo, P. C.: Backache, *Indust. Med.* **15**:642-643 (Nov.) 1946.

417. Hudson, R. T.: Backache, *Kentucky M. J.* **43**:324-327 (Dec.) 1945.

418. Torrance, C. C.: Low Back Pain, *Mississippi Valley M. J.* **68**:112-116 (Oct.) 1946.

419. Walter, A. B.: Weak Back, *Canad. M. A. J.* **54**:252-255 (March) 1946.

420. Stewart, S. F.: Low Back Pain, *Plantation Health* (no. 2) **10**:12-14 (April) 1946.

izing the examination and diagnosis in cases of pain low in the back has been presented by McBride.⁴²³ Conservative treatment of chronic lumbar backache has been outlined by Spithoff.⁴²⁴

Liston⁴²⁵ has reported the vertebral defects, together with other abnormalities of the musculoskeletal system, which were observed in a large number of men who were examined for air crew training. Friedman, Fischer and Van Demark⁴²⁶ have recorded the incidence of roentgenographic abnormalities of the lumbosacral region of the spine in 100 soldiers who had no backache. Moore,⁴²⁷ reporting from a naval hospital, has presented a study of 550 cases of backache; in 4.8 per cent of these the condition was diagnosed as spondylolisthesis and in 5.3 per cent as lumbosacral instability. From these figures and from hospitalization statistics he concluded that applicants for military service should have routine roentgenographic examination of the lumbosacral structures.

Considerable effort is being made to lessen the problem of industrial injuries of the back by job placement based on the findings of pre-employment examinations. O'Connor⁴²⁸ has described a routine appraisal of physical capacity based on history, physical examination and, when indicated, roentgenograms of the back. Such analysis made it possible to employ each person in a job suited to his physical capacity; this policy resulted in a gratifying decrease in the incidence of back strains. Barton and Biram⁴²⁹ analyzed anteroposterior and lateral roentgenograms of the lumbosacral region of the spine made during 1,000 consecutive preplacement examinations. Eight hundred and fifty-six defects were found in 498 of the persons examined. The authors believe that spondylolisthesis, arthritis and in some cases spina

421. Lee, A. E.: Low Backache, *M. J. Australia* **1**:42-44 (Jan. 12) 1946.

422. Larochelle, J. L.: Lumbalgia With or Without Sciatica, *Laval méd.* **11**:505-510 (May) 1946.

423. McBride, E. D.: Examination of Back: Diagnostic Outline for Standardized Routine, *South. M. J.* **39**:867-876 (Nov.) 1946.

424. Spithoff, C. A.: Chronic Lumbar Backache, *Am. J. Surg.* **71**:19-25 (Jan.) 1946.

425. Liston, E.: Diseases and Defects of Musculoskeletal System in Air-Crew Trainees, *J. Bone & Joint Surg.* **28**:466-472 (July) 1946.

426. Friedman, M. M.; Fischer, F. J., and Van Demark, R. E.: Lumbosacral Roentgenograms of One Hundred Soldiers: Control Study, *Am. J. Roentgenol.* **55**:292-298 (March) 1946.

427. Moore, M., Jr.: Military Importance of Low Back Disability, *Mil. Surgeon* **98**:235-236 (March) 1946.

428. O'Connor, R. B.: Physical Capacities Appraisal of Industrial Back, *Indust. Med.* **15**:639-640 (Nov.) 1946.

429. Barton, P. N., and Biram, J. H.: Replacement Examination of Lower Back, *Indust. Med.* **15**:319-322 (May) 1946.

bifida occulta and transitional lumbosacral vertebrae are significant contributing factors in back strains in workers more than 45 years of age.

Several articles have been devoted to the influence of inequality of the lengths of the lower extremities in producing pain low in the back. Rush and Steiner⁴³⁰ have reported a roentgenographic study of length inequality of the lower extremities in 1,000 soldiers who were complaining of pain in the lower part of the back. Anteroposterior and lateral roentgenograms of the pelvis and hips were made with the patient standing; the standing position was standardized by the use of an adjustable support fitting into the mouth. The relative lengths of the lower extremities were measured on the anteroposterior films. No roentgenographic lesions were found in the roentgenograms of the back in a majority of the cases in which there was unequal length of the legs; the authors consider it possible that the symptoms of these patients were associated with the inequality of the length of the legs. Among a group of 100 soldiers who had no pain in the lower part of the back the incidence of inequality in the length of the legs, the degrees of inequality and the roentgenographic incidence of lesions in the lower part of the back were less than in the group of cases in which there was pain in the lower part of the back. Stuckey⁴³¹ found inequality of the lengths of the legs in 26 of 40 soldiers who suffered from backache; he states the belief that the short leg is an important factor in the causation of pain in the back. Articles on this subject have also been published by Butler⁴³² and by Montant.⁴³³

The influence of the orthograde position and the importance of faulty posture as an underlying cause of pain in the lower part of the back have been stressed by Meehan.⁴³⁴ For the treatment of most patients he recommends rest, manipulation and postural exercises.

Backache in women has been discussed by several authors. Geisendorf⁴³⁵ has written on painful lesions of the spine in females, and

430. Rush, W. A., and Steiner, H. A.: Study of Lower Extremity Length Inequality (Using Spinal Fixation and Stabilization Device for Roentgenography), *Am. J. Roentgenol.* **56**:616-623 (Nov.) 1946.

431. Stuckey, D.: Backache in Soldiers, *M. J. Australia* **1**:838-842 (June 15) 1946.

432. Butler, J. M.: Short Leg Backache, *Journal-Lancet* **66**:10-11 (Jan.) 1946.

433. Montant, R.: Backache: Late Sequels of Post-Traumatic Shortening of Lower Extremities; Disorders of Lumbosacral Region, *Helvet. med. acta* **9**:745-786 (Dec.) 1942.

434. Meehan, A. V.: Low Back Pain, *M. J. Australia* **1**:40-42 (Jan. 12) 1946.

435. Geisendorf, W.: Lesions and Backache in Women, *Praxis* **35**:327-330 (May 23) 1946.

Moreno⁴³⁶ has considered the relationships of climacteric and pelvic changes to lumbago and sciatica. McCall⁴³⁷ and Font Sastre⁴³⁸ have pointed out the influence of relaxation of the joints of the pelvis during pregnancy. McCall ascribes postpartum backache to residual changes in the joints, loss of muscle tone and long hours of standing and walking. Gynecologic back pain, according to McCall, is located in the midline in the region of the sacrum and almost never reaches a higher level. It may be caused by (1) inflammatory changes in the pelvic organs and particularly in the uterosacral ligaments; (2) traction exerted by a pyosalpinx, vaginal relaxation, cystocele, rectocele or prolapse; (3) congestion of the uterus and associated structures, and (4) pressure of tumors.

A number of articles in the foreign literature have been devoted to the influence of arthritis and allied conditions in the causation of pain in the lower part of the back. Franceschelli,⁴³⁹ Lachapèle⁴⁴⁰ and Longhi and Zanuso⁴⁴¹ have discussed changes in the intervertebral articulations. Pouyanne⁴⁴² has written on "vertebral rheumatism" and Portela⁴⁴³ on traumatic lumbago. Abnormal relationship of the lower lumbar spinous processes (interspinous osteoarthritis, Baastrup's disease or kissing spine) is the subject of a report by Mouchet.⁴⁴⁴ For this condition a clinical syndrome of midline backache, pain on motion of the lumbar region of the spine, increased lumbar lordosis, diminished mobility and pain on pressure over the spinous processes has been described; roentgenograms are said to show a decreased interval between the spinous processes and sclerosis of their adjacent margins. Patients whose symptoms have not responded to conservative measures have

436. Moreno, B. A.: Lumbagos and Sciaticas: Relation to Climacteric and Pelvic Changes in Female, *Bol. d. Inst. clin. quir.* **22**:57-67 (Jan.-July) 1946.

437. McCall, M. L.: Symposium on Recent Advances in Gynecology: Backache in Women and Uterine Retrodisplacement, *S. Clin. North America* **25**: 1313-1323 (Dec.) 1945.

438. Font Sastre, V.: Symphysis Pubis: Painful Relaxation and Separation of Pelvic Joints During Pregnancy, with Report of Cases, *Rev. españ. obst. y ginec.* **4**:15-24 (Jan.) 1946.

439. Franceschelli, N.: Lumbago, Sciatica and Arthroses (Apophysial, Intersomatic): Physiopathologic Study, *Arch. ortop.* **56**:181-211 (Sept.) 1940.

440. Lachapèle, A. P.: Backache: Role of Posterior Vertebral Articulations, *Rev. du rhum.* **13**:214-217 (July) 1946.

441. Longhi, L., and Zanuso, F.: Apophysial Arthritis of Lumbosacral Region, *Rassegna d. previd. sociale* (no. 12) **27**:16-127 (Dec.) 1940.

442. Pouyanne, L.: "Vertebral Rheumatism" and Lumbar Pain, *Rev. du rhum.* **13**:195-199 (July) 1946.

443. Portela, C. J.: Traumatic Lumbago, *Bol. Liga urug. contra el reumat.* **1**:228-234 (July) 1945.

444. Mouchet, A.: Interspinous Osteoarthritis (Baastrup's Disease, "Kissing Spine"), *Paris méd.* **2**:321-323 (July 27) 1946.

been treated by partial or total resection of the affected spinous processes or by spinal fusion.

In some quarters a revival of interest in possible lesions of the sacroiliac joints is to be noted. Caro and Ingber⁴⁴⁵ have discussed the clinical value of roentgenographic examination of the sacroiliac joint. Travell and Travell⁴⁴⁶ state their belief that slipping of the sacroiliac joint is a common cause of pain low in the back; they treat their patients by injection of procaine hydrochloride into trigger points and by manipulation. Bidwell⁴⁴⁷ similarly expresses the opinion that unilateral sacroiliac subluxation or displacement is a major cause of pain in the lower part of the back; his patients are treated by manipulation, bed rest, restricted exercise and in some instances low back supports. He reports that 140 of 146 patients so treated were relieved of their symptoms. Sierra Cano, Sanchez Trallero, and Sala de Pablo⁴⁴⁸ have written on the surgical treatment of conditions involving the sacroiliac joint. An article on sacroiliac strain and its treatment by arthrodesis according to the technic of Smith-Petersen has been published by Newman.⁴⁴⁹ The operations were performed by Bankart. Newman believes that sacroiliac strain is a definite syndrome which can and should be differentiated from syndromes involving the lumbar region of the spine. He states that the nature of injury is often a torsion strain in either the standing or the sitting position. He thinks that sacroiliac strain is uncommon in the male and that it occurs almost invariably in females between the ages of 15 and 45 years. There may be a history of creaking, especially on sitting down, which is localized accurately to the sacroiliac joint. However, the main point in diagnosis, according to Newman, is the site of pain and tenderness; this is a small area just medial to the posterior superior spine of the ilium or at the upper margin of the great sciatic notch. Radiating pain may involve the lumbosacral area, the groin and the lateral area of the thigh, the posterior part of the thigh and the leg or the lateral aspect of the buttock. Newman believes that the symptoms are associated with abnormal mobility of the sacroiliac joint. He advises first one or more manipulations and states the belief that sacroiliac arthrodesis

445. Caro, D. L., and Ingber, E.: *Sacroiliac Joint: Clinical Value of Roentgen Exploration*, *Rev. argent. de reumatol.* **10**:332-343 (March) 1946.

446. Travell, J., and Travell, W.: *Therapy of Low Back Pain by Manipulation and of Referred Pain in Lower Extremity by Procaine Infiltration*, *Arch. Phys. Med.* **27**:537-547 (Sept.) 1946.

447. Bidwell, A. M.: *Treatment of Sacroiliac Sprain by Manipulation: Report of One Hundred and Forty-Six Cases*, *J. Florida M. A.* **33**:193-196 (Oct.) 1946.

448. Sierra Cano, L.; Sanchez Trallero, A., and Sala de Pablo, J.: *Sacroiliac Joint: Surgical Therapy*, *Rev. españ. cir.* **2**:257-266 (Oct.) 1945.

449. Newman, P. H.: *Sacro-Iliac Arthrodesis*, *Proc. Roy. Soc. Med.* **39**:715-718 (Sept.) 1946.

is indicated if the symptomatic response to manipulation is unsatisfactory. Thirty-six arthrodeses were performed on 32 patients during a period of ten years; over an average follow-up period of four years twenty-one cures were recorded out of a group of thirty-three operations.

[ED. NOTE (R. B. R.).—A few years back, large numbers of patients with pain in the lower part of the back and sciatic pain were treated in this country by sacroiliac arthrodesis. Many were relieved, but the number who did not obtain satisfactory or permanent relief was considerable. Thanks to recent advances in the diagnosis of conditions involving this area, it is now possible in most cases to localize traumatic lesions, with considerable confidence, in structures less stable than the strong sacroiliac joints. I believe that sacroiliac subluxation is uncommon and that for pain low in the back or sciatic pain of mechanical origin sacroiliac arthrodesis is rarely indicated.]

Painful disorders of the adipose tissue of the back have received attention. Murphy⁴⁵⁰ has reviewed the anatomy of fatty tissue in and about the structures of the back, Lifvendahl⁴⁵¹ has called attention to his investigation of this subject in 1937, and Clavero Núñez⁴⁵² has recorded a case of painful symmetric lipomas. Herz⁴⁵³ has reported on 31 patients who were relieved of back pain after the excision of small masses of fatty tissue which had herniated through weak points in the superficial fascia. The clinical picture included a history of injury or strain, severe pain in the lower part of the back which in some cases radiated down one of the lower extremities, a palpable nodule, and relief obtained by the injection of procaine hydrochloride. Microscopic examination of the excised tissue did not reveal definite abnormality.

Sargent⁴⁵⁴ has reported the case of a soldier in whom pain in the lower part of the back developed when he lifted a machine gun and in whom a small tender mass over the sacrospinalis muscle was seen on examination. Surgical exploration revealed a small herniation of the sacrospinalis through a tear in the posterior layer of the lumbodorsal fascia. Repair of the herniation was followed by complete relief of the back pain.

450. Murphy, E.: Low Backache, *M. J. Australia* **1**:44-45 (Jan. 12) 1946.

451. Lifvendahl, R. A.: Herniation of Fascial Fat and Low Back Pain, *Correspondence, J. A. M. A.* **130**:107 (Jan. 12) 1946.

452. Clavero Núñez, A.: Disorders of Adipose Tissue as Cause of Lumbosacralgias in Women: Symmetric Lipomas as Cause of Backache in Case, *Rev. españ. obst. y ginec.* **3**:266-269 (Oct.) 1945.

453. Herz, R.: Herniation of Subfascial Fat as Cause of Low Back Pain: Results of Surgical Treatment in Thirty-One Cases, *J. Internat. Coll. Surgeons* **9**:339-346 (May-June) 1946.

454. Sargent, M.: Localized Back Pain: Separation of Fibers of Posterior Layer of Lumbodorsal Fascia with Herniation of Sacrospinalis Muscle as Cause, *Am. J. Surg.* **71**:338-339 (March) 1946.

Kabat and Jones⁴⁵⁵ have reported the use of neostigmine in the treatment of 47 cases of pain in the lower part of the back attended by muscle spasm. The authors thought that significant relief from pain and improvement in range of motion took place.

Study of a case of sacralization in a child has been recorded by Puig Serrate.⁴⁵⁶ Barba Inclán⁴⁵⁷ has written on the subject of stubborn coccygodynia.

A number of case reports serve to remind the orthopedist that pain in the lower part of the back may be the chief or the sole symptom of visceral disease. Cases of retroperitoneal tumor, pancreatic tumor, duodenal ulcer, ileitis, hiatus hernia and aerophagia in which pain low in the back was the outstanding symptom have been reported by Trumen and Yaskin.⁴⁵⁸ Important features of the back pain in these cases were aggravation in the supine position, increased pain at night and relief on flexion of the spine. Muscle spasm, stiffness of the spine and deformity of the back were absent. In many of these cases the complaint of back pain in the absence of physical signs of a lesion had led to an erroneous diagnosis of neurosis. The authors point out that pain of obscure origin in the lower part of the back, especially in the absence of orthopedic signs, always calls for consideration of a lesion of the gastrointestinal tract and a diagnostic search for such a lesion. Kattwinkel⁴⁵⁹ has reported a case of carcinoma of the body of the pancreas, with presenting symptoms of epigastric distress and back pain. The pain was aggravated by recumbency and relieved by flexion of the spine. A case of bilateral carcinoma of the adrenal glands in which severe lumbar backache was the outstanding symptom has been reported by Zaslow and Bernstein.⁴⁶⁰ Howard⁴⁶¹ has called attention to pain low in the back resulting from retroperitoneal pelvic lymphangitis.

455. Kabat, H., and Jones, C. W.: Neuromuscular Dysfunction: Neostigmine Therapy of Acute and Chronic Backache, *Arch. Phys. Med.* **27**:208-218 (April) 1946.

456. Puig Serrate, J.: Symptomatic Study of Sacralization in Child: Case, *Rev. españ. pediat.* **2**:405-412 (May-June) 1946.

457. Barba Inclán, A.: Stubborn Coccygodynia, *Bol. Sec. san. policía nac.* **1**:135-139 (Oct.-Dec.) 1945.

458. Trumen, H. J., and Yaskin, J. C.: Backache Due to Intra-Abdominal Disease, *Gastroenterology* **7**:294-305 (Sept.) 1946.

459. Kattwinkel, E. E.: Back Pain as Symptom of Carcinoma of Body of Pancreas, *Ann. Int. Med.* **23**:1006-1009 (Dec.) 1947.

460. Zaslow, J., and Bernstein, M.: Bilateral Carcinoma of Adrenal Cortex as Cause of Severe Backache with Report of Case, *J. Urol.* **54**:409-412 (Nov.) 1945.

461. Howard, H. W.: Retroperitoneal Lymphangitis, *Tr. West. Sect., Am. Urol. A.* **12**:81-82, 1944; *Urol. & Cutan. Rev.* **50**:26-27 (Jan.) 1946.

Psychiatric causes of pain in the lower part of the back have been discussed by Sargent.⁴⁶² In the differential diagnosis of such pain, the fact that backache is a frequent complaint in anxiety states should always be kept in mind.

The anatomy, development and growth of human sacral vertebrae have been investigated by Giraudi,⁴⁶³ and the topography of the sacroiliac joints has been studied by Tesoriere.⁴⁶⁴ Lanier and Trotter⁴⁶⁵ have found the volume of the sacral canal to be greater in men than in women and greater in white than in Negro subjects.

A case of "iliac horns" has been reported by Fong.⁴⁶⁶ These processes arose from the posterior surface of the ilia, measuring 2.5 cm. in diameter and projecting 3 cm. laterally and posteriorly. They were easily palpable and caused no symptoms. Associated findings were unusual obliquity of the inferior halves of the sacroiliac joints, rather horizontal lumbosacral joints and an anthropoid type of pelvic inlet. In an addendum to Fong's article the editor of *Radiology* cites a similar case.

The "transverse sacral fold," an abnormal bony sulcus on the posterior aspect of the sacrum, has been found by Trotter and Heath⁴⁶⁷ in 10 of 1,227 sacrums. Each of these 10 sacrums was from a female skeleton; none of 553 male sacrums showed this change. The transverse fold is believed to be a result of anomalous congenital development or of a pathologic fracture in middle or late adult years. The latter view is supported by the age and by the osteoporosis and associated fractures which characterized the 10 skeletons whose sacrums were involved. Narrowing of the posterior sacral foramens was found in association with the transverse folds; the authors are of the opinion that this may be of clinical significance in causing sensory changes and slight muscular atrophy.

Sciatica.—Again a number of articles require indexing under this designation. These papers are from the foreign literature; many report only a single case and several have not been available for review.

462. Sargent, M.: Psychosomatic Backache, *New England J. Med.* **234**:427-430 (March 28) 1946.

463. Giraudi, G.: Microscopic and Roentgenologic Study of Development and Growth of Human Sacral Vertebrae, *Arch. ortop.* **56**:77-103 (July) 1940; Anatomic (Macroscopic and Microscopic) and Roentgenologic Study of Sacral Vertebrae, *ibid.* **56**:221-254 (Sept.) 1940.

464. Tesoriere, A.: Sacroiliac Joint: Topography; Anatomicosurgical Study, *Policlinico (sez. chir.)* **52**:165-177 (Sept.-Oct.) 1945.

465. Lanier, P. F., and Trotter, M.: Volume of Sacral Canal, *Am. J. Phys. Anthropol.* **4**:227-233 (June) 1946.

466. Fong, E. E.: "Iliac Horns" (Symmetrical Bilateral Central Posterior Iliac Processes): Case Report, *Radiology* **47**:517-518 (Nov.) 1946.

467. Trotter, M., and Heath, R. D.: Transverse Sacral Folds, *J. Bone & Joint Surg.* **28**:120-125 (Jan.) 1946.

Sciatica has been discussed by Rogers,⁴⁶⁸ Obarrio⁴⁶⁹ and Edler.⁴⁷⁰ A statistical study of age and sex in cases of sciatic neuralgia has been published by Roger and Schachter,⁴⁷¹ and Costa Bertani⁴⁷² has written on the casuistics of medical sciatica.

Little⁴⁷³ has divided the types of sciatica into a first group without neurologic signs and a second group characterized by their presence; the second group he subdivides into (1) sciatic neuritis of infectious, toxic or metabolic origin and (2) sciatica due to mechanical disturbance of nerve roots by lesions such as spondylolisthesis or protrusion of an intervertebral disk. As an aid in diagnosis, Little uses a "thumb sign"—pain or paresthesia radiating into some part of the dermatome when firm pressure is made over an interspace 1 inch (2.5 cm.) from the midline.

Holmes and Sworn⁴⁷⁴ express the belief that sciatica may be caused by any of a variety of lesions which may affect different levels of the nerves. Within the spinal canal pressure on the nerve root is the commonest cause of symptoms; arthritis of the intervertebral joints may be the most frequent lesion affecting the nerve root in its course through the intervertebral foramen; fibrositis is considered probably responsible for involvement of the nerve after it has emerged from the vertebral column. Although each of the three main levels of nerve involvement tends to produce its characteristic clinical picture, the differential diagnosis is not easy and may be made only by myelography or surgical exploration. The authors present a series of 50 patients who were operated on for the relief of pain attributed to an intraspinal lesion; the most common finding (in 54 per cent of the cases) was a ruptured intervertebral disk.

A consideration of the pathogenesis of sciatica has been published by de Sèze.⁴⁷⁵ Sicard and Gaucher⁴⁷⁶ have reported a case of stubborn

468. Rogers, L.: Sciatica, *J. Roy. Nav. M. Serv.* **32**:209-211 (July) 1946.

469. Obarrio, J. M.: Stubborn Sciatics: Symptomatology and Diagnosis, *Rev. argent. de reumatol.* **11**:118-137 (Aug.) 1946.

470. Edler, K.: Sciatica Therapy in Daily Practice, *Wein. med. Wchnschr.* **96**:392 (Oct. 1) 1946.

471. Roger, H., and Schachter, M.: Statistical Study on Role of Age, Sex, and Localization in Sciatic Neuralgia, *Rev. neurol.* **77**:197-198 (July-Aug.) 1945.

472. Costa Bertani, G.: Medical Sciaticas: Casuistics, *Rev. argent. de reumatol.* **11**:86-116 (July) 1946; *Rev. Asoc. méd. argent.* **60**:464-472 (June 15) 1946.

473. Little, N.: Some Further Observations on Sciatica, *M. J. Australia* **1**:33-37 (Jan. 12) 1946.

474. Holmes, J. M., and Sworn, B. R.: Lumbosacral Root Pain, *Brit. M. J.* **1**:946-948 (June 22) 1946.

475. de Sèze, S.: Anatomic and Physiopathologic Unity in Common Vertebral Sciatica Whether Due to Disk Herniation or Not, *Semaine d. hôp. Paris* **22**:1090-1093 (June 21) 1946.

sciatica attributed to fracture of an articular apophysis; Costa Bertani ⁴⁷⁷ has described a case of sciatic pain which persisted after operation for hypertrophied ligamentum flavum and subsided after medical treatment. Ramond ⁴⁷⁸ has recorded a case of sciatica attributed to tumor of the spinal cord; Diez ⁴⁷⁹ has described 2 cases of stubborn sciatica attributed to intraspinal extradural neurinoma and 1 case attributed to von Recklinghausen's neurofibromatosis of the cauda equina.

Baastrup ⁴⁸⁰ has suggested that in some instances sciatic pain may be caused by inflammatory changes in peritendinous or bursal tissues deep in the gluteal region; he points out certain data which may be considered to support such a hypothesis. Sciatica of uterine origin is the subject of a case report by Astarloa, Peyceré and Nessi.⁴⁸¹

Referred pain in the distribution of the fourth lumbar root, resulting from osteoarthritis of the hip, has been investigated by von Reis ⁴⁸²; he found that considerable relief of such pain could be provided by rhizotomy. Wertheimer and Gautier ⁴⁸³ have presented the results of thirty-four operations for stubborn sciatica. A surgical technic for exposure of the sciatic nerve high under the gluteus maximus muscle has been described by Aird.⁴⁸⁴

Intervertebral Disks.—The role of the normal and the pathologic disk in intervertebral mobility has been studied by Knutsson.⁴⁸⁵ Lateral

476. Sicard, A., and Gaucher, M.: Stubborn Sciatica Due to Fracture of Articular Apophysis: Case, *Presse méd.* **54**:412-413 (June 22) 1946.

477. Costa Bertani, G.: Sciatica, Persisting After Operation for Hypertrophy of Yellow Ligament, Cured by Medical Treatment: Case, *Rev. Assoc. méd. argent.* **60**:584-587 (July 15) 1946.

478. Ramond, L.: Sciatica: Case Due to Tumor of Spinal Cord, *Presse méd.* **54**:530 (Aug. 10) 1946.

479. Diez, J.: Stubborn Sciatica Due to Intraspinal Extradural Neurinoma: Two Cases, *Rev. Assoc. méd. argent.* **60**:171-173 (April 15) 1946; Stubborn Sciatica Due to Recklinghausen's Neurofibromatosis of Cauda Equina: Case, *ibid.* **60**:273-275 (May 15) 1946.

480. Baastrup, C. I.: Possible Relation of Peritendinitis and Bursitis to So-Called Sciatica, *Nord. med.* **16**:3668-3672 (Dec. 26) 1942.

481. Astarloa, E.; Peyceré, F. P., and Nessi, C. T.: Sciatica: Uterine Origin; Case, *Prensa méd. argent.* **33**:1560-1561 (July 26) 1946.

482. von Reis, G.: Sciatica: Pain in Distribution Area of Fourth Lumbar Root; Study of Pain Interpreted as Referred Pain and as Caused by Direct Irritation of Nerve Root, *Acta psychiat. et neurol.*, 1945, supp. 36, pp. 1-135.

483. Wertheimer, P., and Gautier, R.: Comparative Results and Statistics on Thirty-Four Surgical Interventions for Stubborn Sciatica, *Lyon chir.* **41**:33-40 (Jan.-Feb.) 1946.

484. Aird, I.: Exposure of High Lesions of Sciatic Nerve, *Surg., Gynec. & Obst.* **83**:369-372 (Sept.) 1946.

485. Knutsson, F.: Slight and Severe Instability States of Lumbar Spine in Disk Degeneration, *Nord. med.* **31**:1875-1876 (Aug. 23) 1946.

roentgenograms of the normal spine were made with the subject standing in maximum flexion and then in maximum hyperextension; the increased pressure incident to movement was transmitted fairly uniformly throughout the cross section of the disk. The normal disk permits angulation between the vertebrae but sharply restricts parallel displacement. The pathologic disk fails to prevent abnormal tilting and parallel displacement from taking place on motion. Such abnormal movements may contribute to sclerosis of the surfaces of the vertebrae and to lipping of their edges. In 58 of 140 patients the roentgenograms showed anatomic changes which were attributed to degeneration of the disks. Parallel displacement of the overlying vertebrae occurred on backward bending in 8 cases, and slight anterior displacement or pseudospondylolisthesis was noted in 8 cases. In 18 cases parallel displacements were observed in the absence of other signs of degeneration of the disks. Knutsson thought that these patients had incipient degeneration of the disks and that in many instances careful roentgenographic study of such changes might lead to early diagnosis.

Gershon-Cohen⁴⁸⁶ has reported on 3 patients who sustained severe injuries followed by incapacitating low backache for several weeks, without evidence of fracture or dislocation or posterior protrusion of an intervertebral disk. Two of the patients had recurring episodes of pain in the lower part of the back. Subsequently, physical examination showed only slight restriction of lumbosacral mobility, and roentgenograms showed narrowing of the disk space, increased density of the subchondral bone and radiolucence of the disk space, which the author regards as a vacuum phenomenon. Gershon-Cohen discusses these findings, using the term "phantom nucleus pulposus." It is conceivable that loss of nuclear material may take place through an abnormal annulus fibrosus, through defects in the cartilage plates or through a process of degeneration and desiccation.

[ED. NOTE (R. B. R.).—The pathogenesis of extreme narrowing of the lumbosacral disk has not been established. Pain in the lower part of the back associated with this change is to be attributed to secondary malalignment of the facet joints and may be relieved or abolished by an efficient flexion support or by lumbosacral fusion.]

The importance of abnormalities of the intervertebral disks in the causation of backache is receiving increased recognition. Hyndman⁴⁸⁷ has discussed this subject in considerable detail and has presented a classification of degenerative lesions of the disks. He believes that

486. Gershon-Cohen, J.: Phantom Nucleus Pulposus, *Am. J. Roentgenol.* 56: 43-48 (July) 1946.

487. Hyndman, O. R.: Pathologic Intervertebral Disk and Its Consequences: Cause and Treatment of Chronic Pain Low in Back, *Arch. Surg.* 53:247-297 (Sept.) 1946.

degeneration of the disks is a predominant cause of chronic pain low in the back and that degeneration precedes herniation or rupture of the disk. He regards the syndrome of chronic pain in the lower part of the back and the syndrome of sciatica as distinct entities which result from the progressive development of a single pathologic process. Young⁴⁸⁸ has analyzed the spinal mechanics, symptoms and signs in lumbago and has concluded that its probable cause is a lesion of the intervertebral disks. He doubts the existence of fibrositis as an entity and does not think that such a lesion can explain the clinical features of lumbago. In another article Young⁴⁸⁹ has discussed the diagnosis and treatment of partial and complete tears of the annulus fibrosus and has stated his belief that in 90 per cent of cases of backache and in 95 per cent of cases of sciatica the condition is due to pathologic changes in intervertebral disks. Merlino⁴⁹⁰ has discussed disorders of the disks as a cause of lumbar pain in women, and Argüelles⁴⁹¹ has written on the relationship between the ruptured disk and osteochondrosis.

Many reviews covering the more important aspects of the syndrome of the protruded intervertebral disk continue to be published. Love⁴⁹² has presented instances of protrusion at cervical, thoracic and lumbar levels of the spine and discussed the neurosurgical treatment. Experiences with ruptured lumbar disks in military personnel have been reviewed by Whitcomb⁴⁹³ and by King.⁴⁹⁴ Petit-Dutaillis⁴⁹⁵ has reviewed a series of 170 patients who had sciatic pain and who were treated surgically; herniation of an intervertebral disk was found in 125 of the cases. Lindon⁴⁹⁶ has described the changes found at operation in 72 patients for whom the preoperative diagnosis was a lesion of an intervertebral disk; the types of pathologic changes in the disks included

488. Young, J. H.: Lumbago, *M. J. Australia* **2**:485-488 (Oct. 5) 1946.

489. Young, J. H.: Recent Advances in Diagnosis and Treatment of Lumbar Disk Disease, *M. J. Australia* **1**:45-49 (Jan. 12) 1946.

490. Merlino, A.: Disorders of Disks as Cause of Lumbar Pain in Women, *Riforma med.* **60**:324 (June 30) 1946.

491. Argüelles, R.: Hernia of Nucleus Pulposus and Osteochondrosis, *Rev. españ. cir., traumatol. y ortop.* **3**:139-145 (Sept.) 1945.

492. Love, J. G.: Protruded Intervertebral Disk, *S. Clin. North America* **26**:997-1006 (Aug.) 1946.

493. Whitcomb, B. B.: Symposium on Problems in Postwar Medicine: Rupture of Disk, *M. Clin. North America* **30**:431-444 (March) 1946.

494. King, M. K.: Rupture of Lower Lumbar Intervertebral Disks, *Am. J. Surg.* **72**:161-165 (Aug.) 1946.

495. Petit-Dutaillis, D.: Surgical Sciatica and Its Therapy in Connection with One Hundred and Seventy Cases, *Schweiz. med. Wchnschr.* **75**:875-877 (Oct. 1) 1945.

496. Lindon, L.: Problems of Backache and Sciatica, *M. J. Australia* **2**:345-347 (Sept. 7) 1946.

obvious nuclear protrusions, organization of old protrusions and calcification in diseased disks. Lindon attributes no significance to so-called concealed disks. Trumble,⁴⁹⁷ reviewing the diagnosis and treatment of ruptures of the disks, agrees with Lindon on this point. Reviews and discussions of the syndrome of the protruding disk have also been published by Berens,⁴⁹⁸ Spiegel,⁴⁹⁹ Lewin,⁵⁰⁰ Greenwood,⁵⁰¹ Perrot,⁵⁰² Fitte,⁵⁰³ Fernández⁵⁰⁴ and Thiébaud.⁵⁰⁵ Wahren⁵⁰⁶ has reported a surgically proved herniation of a disk which followed a minor injury of the back of a girl 12 years of age.

Two articles deal with the medicolegal aspects of herniated disks. Barr and Craig,⁵⁰⁷ after reviewing the disk syndrome, point out that the percentage of unsatisfactory postoperative results is much greater in insurance cases than in cases in which the patients are not seeking compensation for their injuries. Since the most frequent source of permanent disability is persistent pain and since the pain threshold varies in different persons, the estimation of permanent disability is difficult. Snellman⁵⁰⁸ has enumerated criteria which determine the legal compensability in cases of herniation of disks.

497. Trumble, H. C.: Some Aspects of Diagnosis and Treatment of Prolapsed Intervertebral Discs, *Australian & New Zealand J. Surg.* **15**:159-165 (Jan.) 1946.

498. Berens, S. N.: Ruptured Disc Syndrome: Is It an Orthopedic or Neurosurgical Problem? *J. Omaha Mid-West Clin. Soc.* **7**:63-69 (Aug.) 1946.

499. Spiegel, I. J.: Herniation: Systematized Technic for Investigation and Treatment of Lumbosacral and Low Lumbar Lesions, *Illinois M. J.* **89**:188-196 (April) 1946.

500. Lewin, W.: Sciatica and Prolapsed Intervertebral Disc, *M. Press.* **214**:392-395 (Dec. 19) 1945.

501. Greenwood, J., Jr.: Protruded Intervertebral Disc, *M. Rec. & Ann.* **40**:1289-1290 (Feb.) 1946.

502. Perrot, A.: Backache and Sciatica of Diskal Origin: Pathogenesis, Clinical Aspects and Therapy, *Praxis* **35**:169-173 (March 15) 1946.

503. Fitte, M. J.: Lumbagos and Lumbar Sciaticas, Especially Resulting from Herniated Disk: Cases, *Bol. y trab., Soc. de cir. de Córdoba* **6**:367-384, 1945.

504. Fernández, L. L.: Post-Traumatic Protrusion of Lumbosacral Disks: General Reflections on Lumbagos and Sciaticas, with Report of Case, *Prensa méd. argent.* **33**:1397-1403 (July 5) 1946.

505. Thiébaud, F.: Is Hernia of Disk the Cause or Result of Sciatica? *Paris méd.* **2**:417-419 (Sept. 21) 1946.

506. Wahren, H.: Herniated Nucleus Pulposus in Child of Twelve Years, *Acta orthop. Scandinav.* **16**:40-42, 1945.

507. Barr, J. S., and Craig, W. M.: Ruptured Disks, *J. Nerv. & Ment. Dis.* **103**:688-701 (June) 1946. •

508. Snellman, A.: Pathogenesis of Disk Prolapse in Lumbar Region of Spine and Question of Compensation for Resulting Morbid Condition, *Nord. med. (Duodecim)* **27**:1517-1523 (Aug. 3) 1945.

The diagnosis of ruptured disks is the subject of a group of articles concerned with the clinical findings and of another group devoted to analysis of the roentgenographic findings.

Fincher⁵⁰⁹ has reviewed more than 1,500 neurosurgical records of patients who had pain in the lower part of the back or in the lower extremities; the majority proved to have lesions of the intervertebral disks, while most of the remaining patients suffered from psychologic dysfunction, spinal cord tumor or metastatic tumor. The author discusses the differential diagnosis of these four major entities. In another article Fincher⁵¹⁰ has reviewed the differential diagnosis of ruptured disks and intraspinal tumors in the lumbosacral region. Ray⁵¹¹ has presented case reports illustrating the differential diagnosis of ruptured disk, intradural tumor, radiculitis of various types, intraspinal extradural tumor and extraspinal nerve lesions. O'Connell⁵¹² has discussed the pathologic changes which account for variations in the radiating pain associated with ruptured disks and has reviewed the indications for surgical treatment. Radicular pain due to herniation of a disk and its value in clinical diagnosis have also been discussed by de Sèze, Guillaume and Boulard.⁵¹³ Antoni⁵¹⁴ has reviewed the technic of the neurologic examination in cases of lumbago and sciatica, with especial consideration of the reflexes of the lower half of the body. Donaghy⁵¹⁵ has described the posterior tibial reflex, which is elicited by tapping on the tendon just above and behind the tibial malleolus, and has evaluated its usefulness as a localizing sign. This reflex is not demonstrable in many normal persons; however, its diminution or absence in one leg

509. Fincher, E. F.: *Neurosurgical Experiences in Lumbago-Sciatic Syndrome*, South. M. J. **39**:527-536 (July) 1946.

510. Fincher, E. F.: *Differential Diagnosis of Intervertebral Cartilage Ruptures and Intraspinal Tumors Within Lumbar Sacral Canal*, South. Surgeon **12**:292-304 (Nov.) 1946.

511. Ray, B. S.: *Differential Diagnosis of Ruptured Lumbar Intervertebral Disk*, S. Clin. North America **26**:272-281 (April) 1946.

512. O'Connell, J. E. A.: *Clinical Diagnosis of Lumbar Disk Protrusions with Indications for Their Operative Removal*, Brit. M. J. **1**:122-124 (Jan. 26) 1946.

513. de Sèze, S. G.; Guillaume, J., and Boulard, P.: *Radicular Sciatica Due to Hernia of Intervertebral Disk at Level of Fifth Lumbar or First Sacral Vertebra: Basis of Clinical Diagnosis*, Bull. et mém. Soc. méd. d. hôp. de Paris **62**:347-349, 1946; *Radicular Syndrome of Fifth Lumbar and First Sacral Disks: Value of Clinical Findings for Determining Radicular Topography and Hernias of Intervertebral Disks Without Aid of Lipiodol (Iodized Oil)*, Semaine d. hôp. Paris **22**:1071-1087 (June 21) 1946.

514. Antoni, N.: *Technic of Neurologic Examination in Lumbago and Sciatica, with Special Consideration of Reflexes of Lower Half of Body*, Nord. med. (Hygeia) **20**:2077-2080 (Nov. 27) 1943.

515. Donaghy, R. M. P.: *Posterior Tibial Reflex of Some Value in Localization of Protruded Disk in Lumbar Region*, J. Neurosurg. **3**:457-459 (Sept.) 1946.

in the presence of an active reflex in the other leg is considered by Donaghy to be suggestive of a lesion at the interspace between the fourth and fifth lumbar vertebrae. Since the knee and ankle jerks are likely to be normal, the posterior tibial reflex may prove to be of considerable diagnostic value. Money⁵¹⁰ recommends the diagnostic injection of procaine solution through the sacral hiatus after a second needle has been placed in the third lumbar interspace. If the sciatica is due to a lesion peripheral to the exit of sacral or lumbar nerves from the foramina, the pain is first slightly increased and then relieved by the injection; if the sciatica is due to a root lesion, each injection, by increasing the pressure on the root, causes an exacerbation of the original pain.

A number of articles have been devoted to the roentgenographic diagnosis of protrusions of disks. Gillespie⁵¹⁷ analyzed 160 cases of proved lesions of the disks and was impressed with the diagnostic value of ordinary roentgenograms; the most useful findings were narrowing of the intervertebral space and localized osteoarthritic changes. Peterson⁵¹⁸ and Lindblom⁵¹⁹ have also discussed the roentgenographic diagnosis. "Pantopaque" myelography is the subject of articles by Maltby and Pendergrass,⁵²⁰ Copleman,⁵²¹ Rocca and Cordero,⁵²² and Lange and Zaclis⁵²³; in addition, Andolf and Eneroth⁵²⁴ have written on myelography with a water-soluble contrast medium.

Peacher and Robertson⁵²⁵ have investigated the absorption of "pantopaque" by making roentgenograms at intervals after myelography. Roentgenograms of the skull showed small amounts of the contrast medium in the basal cisterns in nearly one fourth of the patients. A single benign meningeal reaction occurred after intracranial progres-

516. Money, R. A.: Sciatica, *M. J. Australia* **1**:37-40 (Jan. 12) 1946.

517. Gillespie, H. W.: Radiologic Diagnosis of Lumbar Disk Lesions: Report on One Hundred and Sixty Cases, *Brit. J. Radiol.* **19**:420-428 (Oct.) 1946.

518. Peterson, H. O.: Value of X-Ray Examination in Diagnosis of Ruptured Disk, *Minnesota Med.* **29**:904 (Sept.) 1946.

519. Lindblom, K.: Roentgen Diagnosis of Prolapse, *Nord. med.* **30**:1173-1176 (May 31) 1946.

520. Maltby, G. L., and Pendergrass, R. C.: Pantopaque (Iodine Preparation) Myelography: Diagnostic Errors and Review of Cases, *Radiology* **47**:35-46 (July) 1946.

521. Copleman, B.: Pantopaque Myelography: Indications and Technic, *J. M. Soc. New Jersey* **43**:460-461 (Nov.) 1946.

522. Rocca, E. D., and Cordero, R.: Pantopaque in Myelography, *Arch. Soc. cirujanos hosp.* **16**:394-397 (June) 1946.

523. Lange, O., and Zaclis, J.: Perimyelography with Pantopaque, *Arq. neuro-psiquiat.*, São Paulo **4**:133-141 (June) 1946.

524. Andolf, N., and Eneroth, S.: Herniated Disk and Myelography with Water-Soluble Contrast Medium, *Nord. med. (Hygeia)* **29**:23-27 (Jan. 4) 1946.

525. Peacher, W. G., and Robertson, R. C. L.: Absorption of Pantopaque (Iodine Preparation) Following Myelography, *Radiology* **47**:186-187 (Aug.) 1946.

sion of the "pantopaque." The rate of absorption of residual "pantopaque" seemed to be most rapid during the first four to six months.

James⁵²⁶ has reported a case of narrowing of the third and fourth lumbar interspaces after lumbar puncture; the author suggests that the lumbar puncture may have caused collapse of the intervertebral disks. The patient, of unstated age, received a lumbar puncture for the investigation of convulsions. One week later he was hospitalized for rigidity and tenderness of the lumbar region of the spine, pain on flexion of the hips and a cautious gait. During the hospitalization chickenpox developed. Serial roentgenograms showed initially a narrowing of the third interspace and later a narrowing of the fourth interspace followed by erosion and finally sclerosis of the upper surface of the fourth lumbar vertebra. The patient was treated by plaster immobilization for six months.

[ED. NOTE (R. B. R.).—It seems unlikely that the disk changes were a result of lumbar puncture. Unfortunately the author does not state what interspace was punctured and whether any technical difficulty was encountered. Detailed, pertinent information is particularly desirable when the author's case is contrary to usual experience and an indictment of a commonly accepted form of treatment.]

The prognosis in cases of protruded disks is the subject of several articles. Dunning,⁵²⁷ in a study of 55 cases, found that the neurologic signs and the protein content of the spinal fluid were of no prognostic value. The outlook for relief of pain appeared to be better when the first attack of sciatica occurred in the older age period. Of 60 patients operated on and reported by Schlin, Selverstone and Scribner,⁵²⁸ 4 had bilateral herniations and 10 had multiple herniations; thus nearly one fourth of the patients had more than a single unilateral protrusion. In 5 cases the myelograms were noncontributory but ruptured disks were found at operation. The authors offer these facts in explanation of some of the unsatisfactory results of the treatment of ruptured disks. Three cases of recurrent herniation have been reported by Alajouanine and Thurel.⁵²⁹

An experimental study bearing on surgical treatment has been reported by Haas.⁵³⁰ He found that in dogs the removal of an inter-

526. James, U.: Collapsed Disks Following Lumbar Puncture, *Proc. Roy. Soc. Med.* **39**:134-135 (Jan.) 1946.

527. Dunning, H. S.: Prognosis in So-Called Sciatic Neuritis, *Arch. Neurol. & Psychiat.* **55**:573-577 (June) 1946.

528. Schlin, F. A.; Selverstone, B., and Scribner, W. E.: Bilateral and Multiple Ruptured Disks as Cause of Persistent Symptoms Following Operation for Herniated Disk, *Surg., Gynec. & Obst.* **83**:485-493 (Oct.) 1946.

529. Alajouanine, T., and Thurel, R.: Recurrent Hernia: Three Cases, *Rev. neurol.* **78**:51-53 (Jan.-Feb.) 1946.

530. Haas, S. L.: Fusion of Vertebrae Following Resection, *J. Bone & Joint Surg.* **28**:544-549 (July) 1946.

vertebral disk by excision and curettage through an abdominal approach is followed by bony bridging between the adjacent vertebral bodies. Complete union prevented motion at the articular facets. Incomplete union produced considerable fixation of the bodies but allowed motion between the facets. In young growing animals the union was more rapid and more often of completely osseous quality. With bony union there was a tendency for buckling toward the spinal canal to take place.

Writing on the technic of disk operations, Clark⁵³¹ advocates removal of the herniated or degenerated disk in its entirety. He also removes as much as possible of the cartilage plates, using a side-cutting electrically driven burr in an attempt to produce union between the vertebral bodies. Clark reports 45 consecutive cases; in 30 he classifies the result as satisfactory, while 15 of the patients continued to have pain in the back on exertion. He attributed these failures to poor operative judgment, faulty technic or inadequate surgical instruments. [ED. NOTE (R. B. R.).—It seems not unlikely that the percentage of failures would have been less if the patients had had the benefit of fusion by one of the accepted posterior technics.] As an adjunct to spinal fusion by the time-tested interlaminar technic, Jaslow⁵³² drives a small peg of bone taken from a spinous process into the intercorporal space after removal of the disk and cartilage plates. He states the belief that this procedure maintains the height of the disk space, provides increased stability and tends to promote bony union.

Kalima⁵³³ has recorded his technic of excising herniations of disks. It includes displacement of the nerve root medially when possible, electrocoagulation of veins on the surface of the herniation and thorough removal of disk tissue by means of especially designed instruments. Guillaume⁵³⁴ also has described an operative technic for the treatment of lesions of the disk. Robertson and Peacher⁵³⁵ have reported a technic for preserving and replacing the ligamentum flavum and an alternative procedure of covering the exposed interlaminar space with tantalum foil. Before adopting these measures they had found extensive adhesions from paraspinal muscles down to the dura and the adjacent nerve roots in 10 of 12 backs which were reexplored because of per-

531. Clark, F. J.: Recent Advances in Surgical Treatment of Lumbar Disk Disease, *M. J. Australia* 1:49-52 (Jan. 12) 1946.

532. Jaslow, I. A.: Intercorporal Bone Graft in Spinal Fusion After Disk Removal, *Surg., Gynec. & Obst.* 82:215-218 (Feb.) 1946.

533. Kalima, T.: Simple, Thorough Operative Technic for Excision of Disc Herniation, *J. Internat. Coll. Surgeons* 9:531-535 (Sept.-Oct.) 1946.

534. Guillaume, J.: Simple Operative Technic in Diskal Sciatica, *Rev. neurol.* 78:154-156 (March-April) 1946.

535. Robertson, R. C. L., and Peacher, W. G.: Herniation of Nucleus Pulposus: Refinement in Operative Technic, *Surgery* 18:768-772 (Dec.) 1945.

sistent or recurrent symptoms. In 188 subsequent cases in which operation was performed by these technics the end results were superior to those in an earlier series. [ED. NOTE (R. B. R.).—Adequate occlusion of the interlaminar space is, of course, essential when excision of the disk is to be followed by spinal fusion with chip grafts.] Hirsch⁵³⁶ has reported on 2 patients who had signs of nerve root compression although the myelograms revealed no abnormality; at operation on each the prolapsed disk was found in the intervertebral foramen. The intervertebral joints were resected and the disks removed, with satisfactory early relief of the symptoms. Fernández⁵³⁷ has discussed the exploration of intervertebral disks in the course of fusion operations, and de Sèze, Guillaume, Boulard and Mazars⁵³⁸ have described a technic for identifying the individual intervertebral space.

Reports of the end results of excision of disks, with or without arthrodesis, continue to be published; their interpretation is difficult, and in some respects their content is conflicting. Friberg and Hirsch⁵³⁹ report a five year follow-up study of 44 patients who were operated on for prolapse of a lumbar disk. In 37 cases herniation had been demonstrated and in 5 cases disk degeneration; in 2 cases the findings were normal. Of the 44 patients, 42 were capable of work; 32 of these returned to their old jobs, which in 22 instances consisted of physical labor. Of 37 patients with proved herniations, 31 were free from sciatic pain. Spinal fusion was not done in any of these cases. All the patients complained of a certain amount of back discomfort for a period of one to three years after operation. The authors consider arthrodesis at the time of excision of the disk unnecessary but recommended it as a later procedure if the pain in the lower part of the back fails to subside satisfactorily. In 5 instances lesions of a disk were demonstrated at operation but postoperative roentgenograms showed no abnormality; the authors concluded that the state of the disks cannot always be properly evaluated on roentgenographic evidence alone. Reviews of

536. Hirsch, C.: Intervertebral Foraminotomy, *Acta chir. Scandinav.* **94**: 75-80, 1946.

537. Fernández, L. L.: Lumbagos and Lumbosciaticas: Exploration of Disk in Course of Lumbosacral Osseous Fusion, *Prensa méd. argent.* **33**:649-660 (March 29) 1946.

538. de Sèze, S.; Guillaume, J.; Boulard, P., and Mazars, G.: Technical Procedure Permitting Easy Identification of Intervertebral Space: Deep Pre-operative Alignment Staining Under Radiologic Control; Step Forward in Minimizing Surgery for Sciatica, *Bull. et mém. Soc. méd. d. hôp. de Paris* **62**:179-180, 1946.

539. Friberg, S., and Hirsch, C.: Late Results of Operative Treatment for Disk Prolapses in Lumbar Region: Preliminary Report, *Acta chir. Scandinav.* **93**:161-168, 1946.

postoperative results have been published also by Samson and Jarry,⁵⁴⁰ Lehmann,⁵⁴¹ and Briggs and Keats.⁵⁴² Diéz⁵⁴³ has added 14 cases to his previously reported series. Compere⁵⁴⁴ advocates interlaminar spinal fusion when the herniation of a disk is removed. He expresses the opinion that failure to protect the involved segments results during the course of the following one to five years in the development of osteoarthritic changes in the articular facets and margins of the vertebral bodies. He cites 3 cases in which fusion was not carried out and in which arthritic changes took place.

Two articles are concerned with end results in military personnel. White and Peterson⁵⁴⁵ found that 75 per cent of a group of 39 officers and enlisted men were able to return to full or partial military duty after removal of a herniated disk. The authors think that the operation should be performed only in clearcut cases and on otherwise healthy persons who are eager to return to duty. Mayfield⁵⁴⁶ has reviewed 126 cases of patients treated surgically for disk herniations. Seventy-four per cent returned to duty, and an additional 10 per cent were much improved. Mayfield advises spinal fusion in about 10 per cent of the cases; this group includes patients with spondylolisthesis, extensive local arthritis, defective local facets or persistent or recurrent symptoms following the previous removal of a protruding disk.

Spondylolysis and Spondylolisthesis.—Lerner and Gazin⁵⁴⁷ examined the roentgenograms of 511 patients with pain in the back at an Army Air Force Regional Hospital; they found 52 instances of isthmus hiatus, in 19 of which spondylolisthesis was present. The authors believe that spondylolysis may be attended by sufficient instability to cause

540. Samson, A., and Jarry, L.: Surgical Therapy of Hernia: Cases, *Ann. méd.-chir. de l'Hôp. Sainte-Justine, Montréal* 5:109-116, 1946.

541. Lehmann, P. O.: Protruded Disk: Sixty Operative Cases, *Bull. Vancouver M. A.* 22:56-60 (Dec.) 1945; *J. Canad. M. Serv.* 3:244-250 (March) 1946.

542. Briggs, H., and Keats, S.: Clinical Experiences in Treatment of Low Back and Sciatic Pain Associated with Disorders of Intervertebral Disk, *J. M. Soc. New Jersey* 43:13-18 (Jan.) 1946.

543. Diéz, J.: Stubborn Sciatica Due to Hernia of Disk: Late Results in Surgical Therapy of Fourteen Additional Cases, *Bol. y trab., Acad. argent. de cir.* 30:459-496 (July 17) 1946.

544. Compere, E. L.: Fusion of Spine After Removal of Ruptured Disk, *J. Internat. Coll. Surgeons* 9:14-19 (Jan.-Feb.) 1946; *South. M. J.* 39:301-306 (April) 1946.

545. White, J. C., and Peterson, T. H.: Lumbar Herniations: Value of Surgical Removal for Naval Personnel, *Occup. Med.* 1:145-159 (Feb.) 1946.

546. Mayfield, F. H.: Herniated Nucleus Pulposus: Protruded Disks, *J. Michigan M. Soc.* 44:1206-1209 (Nov.) 1945.

547. Lerner, H. H., and Gazin, A. I.: Interarticular Isthmus Hiatus (Spondylolysis), *Radiology* 46:573-578 (June) 1946.

degeneration of the intervertebral disk, which in turn may produce either spondylolisthesis or herniation of the disk. McMaster and Dula⁵⁴⁸ have found 23 cases of spondylolysis among 350 patients with pain in the back.

Meyerding and Flashman⁵⁴⁹ have reviewed briefly the subject of isthmus defects of the lumbar vertebrae and reemphasized the diagnostic value of oblique roentgenograms. They appended reports of 7 patients who complained of backache with little or no pain in the lower extremities and whose roentgenograms showed isthmus defects; in 4 of these patients grade I spondylolisthesis was present also. Faulong⁵⁵⁰ has pointed out the existence of traumatic spondylolysis and called attention to the necessity of obtaining clear roentgenograms, including the oblique views.

Meschan⁵⁵¹ has reviewed his method of measuring spondylolisthesis radiographically and has studied the stability of the spine in cases of spondylolisthesis. If routine anteroposterior, lateral and oblique roentgenograms indicate the presence of an isthmus defect, additional lateral views are made with the spine in flexed, neutral and hyperextended positions and with the patient standing. In the roentgenograms of 520 spines the author found 61 defects of the neural arch; two thirds of these were bilateral. Of the 42 patients with bilateral defects, 62 per cent were thought to have spondylolisthesis, 19 per cent were considered "borderline," and 19 per cent showed no spondylolisthesis. By analyzing the various lateral roentgenograms Meschan was able to demonstrate instability in 14 of 26 cases of spondylolisthesis. No instability could be demonstrated in the patients with borderline defects or in persons with isthmus defects without spondylolisthesis. Correlation between instability and clinical symptoms was not attempted in these reports.

Gallucio,⁵⁵² in a study of the roentgenograms of 811 backs, found that 8.5 per cent showed spondylolysis or spondylolisthesis. He thinks that the incidence may be greater than this, since some of the roentgenographic examinations were incomplete. He recommends the use of

548. McMaster, P. E., and Dula, F. M.: Prespondylolisthesis: Twenty-Three Cases, U. S. Nav. M. Bull. **46**:1077-1082 (July) 1946.

549. Meyerding, H. W., and Flashman, F. L.: Backache (Due to Defects of Isthmic Zone of Vertebrae), J. A. M. A. **130**:75-78 (Jan. 12) 1946.

550. Faulong, L.: Frequency of Traumatic Spondylolyses with Unperceived Spondylolisthesis: Diagnostic Difficulty; Cases, Rev. du rhum. **13**:8-11 (Jan.) 1946.

551. Meschan, I.: Radiographic Analysis of Spondylolisthesis, M. J. Australia **1**:465-469 (April 6) 1946; Radiographic Study of Spondylolisthesis, with Reference to Stability Determination, Radiology **47**:249-262 (Sept.) 1946.

552. Gallucio, A. C.: Spondylolisthesis: Further Remarks with Emphasis on Radiologic Aspects, Radiology **46**:356-363 (April) 1946.

six views: routine anteroposterior, 35 degree anteroposterior, right oblique, left oblique, routine lateral and upright lateral. Garland and Thomas,⁵⁵³ in a study of military personnel, report that in 10 per cent of the cases pain in the lower part of the back is attributable to spondylolisthesis. On the basis of roentgen studies, Roche and Bryan⁵⁵⁴ have discussed various morphologic types of spondylolysis and spondylolisthesis.

Cabras⁵⁵⁵ has reviewed the subject of spondylolisthesis, presented 10 cases and expressed his preference for nonsurgical treatment. Guri⁵⁵⁶ has reported that 41 per cent of 34 patients with painful spondylolisthesis were relieved of their symptoms by nonsurgical treatment, 35 per cent were partially relieved and 24 per cent obtained no relief. He reports that good results were obtained in 69 per cent of a corresponding series of patients who were treated by arthrodesis. Spray and Ghormley⁵⁵⁷ have described the excellent result eight years after arthrodesis in a patient who had been a paratrooper and had made several jumps without difficulty. Stone⁵⁵⁸ has reported a case of spondylolisthesis treated by arthrodesis with metallic internal fixation.

XII. CONDITIONS INVOLVING THE ELBOW, THE FOREARM, THE WRIST AND THE HAND

Prepared by

WALTER C. GRAHAM, M.D., SANTA BARBARA, CALIF.

Surgical Anatomy.—Murphey, Kirklin and Finlayson⁵⁵⁹ reported a study of the anomalous innervation of the intrinsic muscles of the hand. They stressed the old conception that motion of a part is of little value in the evaluation of the function of the intrinsic muscles and that it is

553. Garland, L. H., and Thomas, S. F.: Spondylolisthesis: Criteria for More Accurate Diagnosis of True Anterior Slip of Involved Vertebral Segment, *Am. J. Roentgenol.* **55**:275-291 (March) 1946.

554. Roche, M. B., and Bryan, C. S.: Spondylolisthesis: Additional Variations in Anomalies in Pars Interarticularis, *Arch. Surg.* **53**:675-682 (Dec.) 1946.

555. Cabras, G.: Spondylolisthesis, *Chir. d. org. di movimento* **30**:57-89 (Jan.-March) 1946.

556. Guri, J. P.: Treatment of Painful Spondylolisthesis, *Surg., Gynec. & Obst.* **83**:797-806 (Dec.) 1946.

557. Spray, P. E., and Ghormley, R. K.: Results in Case of Spondylolisthesis Eight Years After Spinal Fusion, *Proc. Staff Meet., Mayo Clin.* **21**:150-151 (April 3) 1946.

558. Stone, M. M.: Spondylolisthesis, Fusion with Internal Metal Fixation: Case, *Cir. orthop. y traumatol., Habana* **12**:183-188 (Oct.-Dec.) 1945.

559. Murphey, F.; Kirklin, J. W., and Finlayson, A. I.: Anomalous Innervation of Intrinsic Muscles of Hand, *Surg., Gynec. & Obst.* **83**:15-23 (July) 1946.

important that the belly of the muscle be palpated to determine function. The function of various muscles which are amenable to accurate testing is given, each muscle being considered individually. An extensive study of anomalous innervation is presented.

Four cases were presented in which the first dorsal interosseous muscle was innervated by the median nerve. A total of 698 cases of ulnar nerve injury were encountered. An excellent and complete discussion of the anomalous cases is given which stresses the importance of testing the interosseous muscles of the hand in the accurate assessment of peripheral nerve injuries.

A study of innervation of the flexor digitorum profundus and the lumbrical muscles was reported by Sunderland.⁵⁶⁰ This study was made to determine whether any relationship existed between the nerve supply of the lumbrical muscles and the nerve supply of the flexor digitorum profundus, with which it is associated. He concluded that the nerve supply of the lumbrical muscle is not necessarily the same as that of the fibers of the flexor profundus controlling the tendon and digit with which the lumbrical muscle is associated. The parts of the flexor mass supplied by the median and ulnar nerves and the relationships existing between them were also investigated and described. A further article by Sunderland⁵⁶¹ in regard to innervation of the first dorsal interosseous muscle states that in 100 dissections three muscles were found to be entirely innervated by the median nerve and another to be partially innervated by the median nerve. In 1 case a superficial radial nerve gave a terminal branch to the right first dorsal interosseous muscle. From clinical observation, he states that in 5 of 41 cases median nerve supply to the first dorsal interosseous muscle was demonstrated.

He discussed a statement by McKenzie which claims that the first dorsal interosseous has no flexor control on the proximal joint but extends the distal two joints. The lumbricales flex the proximal joint and exert no action on the distal two joints.

A further analysis of the relationship of the extensor digitorum communis tendon to the metacarpophalangeal joint is made by Kaplan.⁵⁶² He discusses the work of Duchenne, who in his analysis of the component parts responsible for the harmonious action of the common extensor muscle and the intrinsic muscles of the hand emphasizes the

560. Sunderland, S.: Innervation of Flexor Digitorum Profundus and Lumbrical Muscles, *Anat. Rec.* **93**:317-321 (Dec.) 1945.

561. Sunderland, S.: Innervation of First Dorsal Interosseous Muscle of Hand, *Anat. Rec.* **95**:7-10 (May) 1946.

562. Kaplan, E. B.: Relation of Extensor Digitorum Communis Tendon to Metacarpophalangeal Joint, *Bull. Hosp. Joint Dis.* **6**:149-154 (Oct.) 1945.

great importance of a special insertion of the extensor communis tendon to the base of the proximal phalanx.

The author of this article is among those who had found the insertion important and constant (1939), but after observation and the accumulation of more material noticed that in some fingers the special insertion did not exist. This prompted a resumption of the study with the purpose of establishing more accurately the nature of the special insertion, its incidence and its functional significance. He concludes that the arrangement of the extensor tendon over the metacarpophalangeal joint is functionally essential because it contributes the following important factors: (1) extension and hyperextension of the proximal phalanx, which permits the interosseous-lumbrical unit to extend the two distal phalanges and (2) stabilization of the metacarpophalangeal joint when the finger is in extension.

Ghigi⁵⁶³ presents a study of the carpal scaphoid bone and describes in detail the location and shape of the scaphoid and its particular mechanical and internal structure. He feels that the bone has the same function in the wrist as the astragalus has in the foot. Its location explains the frequency of fracture, as any forceful stimuli from wrist to forearm or vice versa pass through it. The scaphoid, because of its construction, has a tendency to break into two fragments, the structure being least strong in the middle third.

Pomeranz⁵⁶⁴ thinks that the supracondylar process, or the spur, is possibly a vestigial remnant of what was a bony bridge serving to protect the blood vessels and the nerve which pass through it. It is generally described as a small, composite bony projection on the medial and anterior surfaces of the humerus, about 6.5 cm. above the lower articular margin. The process is broad at the point of origin and tapers to a relatively sharp end. Its long axis is crescentic, with the convexity directed medially. The cortex of the humerus, where it arises, is unaltered. A phylogenetic variant is found in lower species of mammals, reptiles and amphibians. Clinically, this process appears to be without significance, and it is usually discovered accidentally in the course of routine examinations of the elbow joint.

An interesting study on the conditions just described was made by Barnard and McCoy.⁵⁶⁵ They state that it appears in about 1 per cent

563. Ghigi, C.: Contributo allo studio dell'anatomia topografica della Meccanica articolare e della costituzione interna dell'osso navicolare, *Chir. d. org. di movimento* 30:106-116 (Jan.-March) 1946.

564. Pomeranz, M. M.: Radiographic Vignettes: Supracondylar Process, *Bull. Hosp. Joint Dis.* 6:80-81 (Oct.) 1945.

565. Barnard, L. B., and McCoy, S. M.: Supracondyloid Process of Humerus, *J. Bone & Joint Surg.* 28:845-850 (Oct.) 1946.

of persons of European ancestry. Three cases are presented, in 2 of which the symptoms involved the median nerve. They are of the opinion that the median nerve passes beneath the spur, producing pressure. Surgical excision in 1 case resulted in immediate relief of the pain in the median nerve.

A method of assessment of skeletal development of the hand is presented by Michelson.⁵⁶⁶ He states that the study is still in an experimental stage and is most difficult in the age group in which the appearance of ossification centers cannot be used as landmarks. He has formulated a criterion which involves twenty-two consecutive stages. The bone length is actually considered as a separate entity in order not to confuse the increase in the longitudinal dimension with the morphologic criterion of malnutrition. The growth factors are determined by measuring the diaphysis and epiphysis and by the calcification connecting them.

The classification of the consecutive stages of development of the hand skeleton, including twenty-one stages, is presented, and the findings in each stage are revealed.

Surface Covering.—As a result of World War II, considerable work was done on the covering of surfaces of the hands. A rather extensive and complete article is presented by Webster and Rowland.⁵⁶⁷ A review of the types and methods of skin grafting on the dorsum of the hand to replace loss of skin from severe burns is presented.

They have a new classification which divides the old "three degrees" into subgroups, first degree burns being divided into two groups, second degree burns into three groups and third degree burns into three groups. The subdivision has to do with the injury together with the clinical appearance in relation to the time interval following the burn.

A plea is made for early grafting whenever possible and for treatment directed toward early closure of the wound. The fundamental principles of cleanliness and compression are emphasized as well as the general care of the patient and the use of chemotherapy. The problems of the choice of method of grafting and of the so-called "temporary grafting" and the indications for such are discussed. The temporary graft is one that is put on primarily for closure with the knowledge that later a more extensive type of procedure will be necessary. The prevention of contractures and the placing of the fingers in a position of function are stressed. The importance of irregular borders of the grafts to prevent contractures and of the control of the recurring web formation between the fingers is brought out.

566. Michelson, N.: Method for Assessing Development of Hand Skeleton, *Am. J. Phys. Anthropol.* 4:235-242 (June) 1946.

567. Webster, G. V., and Rowland, W. D.: Skin-Grafting Burned Dorsum of Hand, *Ann. Surg.* 124:449-462 (Aug.) 1946.

into the flexor sheath. Two needles were placed through the incisions, and the penicillin was washed through the tendon sheath. These injections, were repeated daily, and penicillin was given intramuscularly at two to four hour intervals.

In another article on infections of the hand, Newton⁵⁷⁴ presented several cases—1 of a soft tissue infection of the distal phalanx, 2 of infections of the web or the commissural space and 3 of suppurative tenosynovitis of the flexor tendon sheath. He stresses the importance of adequate surgical drainage and gives an illustration of the type of incision which he uses. The incision is longitudinal and crosses the distal palmar crease of the hand. He is of the opinion that this gives more adequate drainage than the transverse incision.

[ED. NOTE.—I doubt the advisability of extending the incision across the flexor crease.]

An excellent and extensive article on the general consideration of infections of the hand was presented by Requarth.⁵⁷⁵ It is the author's feeling that in cases of acute cellulitis the hand should not be opened within twenty-four hours, that period being used for wet packing while localization is being awaited. The surgical procedure is done under general anesthesia, with a tourniquet to control bleeding.

Requarth discusses the proper incision to prevent contractures. The so-called fish-mouth incision should not be used in an operation for a felon. For the treatment of aronychia, he advocates a longitudinal incision into the side of the nail; the skin is retracted over the base of the nail and the undermined portion cut away. In the collar button type of abscess, the incision is made proximal to the web and parallel to the distal palmar crease.

An extensive discussion is presented on infections of the flexor tendon sheath and on the type of drainage indicated. The treatment of infections of the subcutaneous and subaponeurotic spaces is entirely covered, as well as the seriousness of the human bite of the hand.

Moses⁵⁷⁶ presents two articles on early and differential diagnosis of infections of the hand. The first article deals with differentiation of soft tissue infections of the finger from tenosynovitis. He tests by resisting flexion of the finger, which he does by catching beneath the tip of the finger nail. The resistance on the finger nail prevents pressure at the site of the inflammation and thus helps to localize the infection as pressure pain is eliminated. In cases of soft tissue infections the pain

574. Newton, N. G.: Serious Infections of Hand and Penicillin, *M. J. Australia* 2:129-131 (July 27) 1946.

575. Requarth, W. H.: Diagnosis and Treatment of Localized Infections in Hand, *U. S. Nav. M. Bull.* 46:1354-1367 (Sept.) 1946.

576. Moses, W. R.: Diagnosis of Acute Flexor Tendon Tenosynovitis, *Surg., Gynec. & Obst.* 82:101 (Jan.) 1946.

will not be increased, but in cases of tendon infection there will be considerable increase of pain, which will extend along the palmar aspect of the finger because of the bow string of the tendon against the sheath. The second article⁵⁷⁷ deals with the diagnosis of abscess of the thenar space. The author states the belief that there is a significant limitation of components controlled by the adductor pollicis muscle in abscesses of the thenar space. He advocates early drainage and presents a test which he considers will aid in the early diagnosis.

The test consists of putting the adductor muscle of the thumb under tension. In the performance of the test, the hand is put flat on the table and an object such as a match is put between the abducted thumb and the index finger. In the attempt to adduct, it will put pressure on the pus if any is present and produce considerable pain. The diagnosis made by means of this test has been proved in 6 cases by operative findings.

Acute Injuries of the Tendon.—A study of 32 cases of lacerated tendons of the hand was presented by Hertzberg.⁵⁷⁸ The flexor tendon was cut in 5 cases and the extensor in 27. Nine of the extensor injuries were complicated by other damage. The author advocates a limit of six hours for primary suturing of extensor tendons and two hours for that of flexor tendons. He feels that when the wound heals by primary intention secondary suturing can be carried out within one month. For infected wounds, he waits from six months to a year and a half, depending on the duration of infection.

Tendon sutures are contraindicated in the following instances: (1) when the tendon is not totally divided, (2) when only one of the two extensor tendons is divided, (3) when the extensor tendon is injured at the insertion in the distal phalanx, (4) when only the superficial flexor is cut, (5) when only the deep flexor tendon is cut (suturing should be done only when conditions are good) and (6) when both flexor tendons are cut (only the deep one should be sutured).

A review of cases is presented.

Ledergerber⁵⁷⁹ presented what he considers a simpler method of treatment of avulsion of the extensor tendon of the finger. He utilizes the finger nail as an aid to splinting, two holes being put through the portion of the nail which protrudes beyond the tip of the finger. A dorsal splint is fixed to the nail with a suture, the splint being padded

577. Moses, W. R.: Diagnosis of Thenar Space Abscess, *Am. J. Surg.* **72**: 583-584 (Oct.) 1946.

578. Hertzberg, J.: Treatment of Injuries of Tendons of Hand, *Nord. med.* **31**:1893-1897 (Aug. 23) 1946.

579. Ledergerber, E.: Ein Beitrag zur unblutigen Behandlung des Strecksehnenabrisses der Finger, *Schweiz. med. Wchnschr.* **75**:1088-1089 (Dec. 8) 1945.

by gauze over the distal joint and the remainder of the splint fixed with adhesive tape. He advocates splinting for a period of six weeks.

The disadvantage of plaster fixation is discussed by Schaubel and Smith.⁵⁸⁰ A splint is described as constructed from a tongue blade, with a piece of cork glued to it to maintain hyperextension of the distal joint.

General Consideration of Treatment of Injuries of the Hand.—There were many well written and well presented general articles dealing with injuries of the hand. Cleveland⁵⁸¹ states that in 72 per cent of patients with war injuries who survived to reach military hospitals the extremities were involved. In two fifths of the cases the upper extremities were injured. The problem of immediate care of wounds on the hands is frequently complicated by multiple wounds on other portions of the body. Often the wound in the hand is neglected because lifesaving measures are necessary.

A general discussion on the necessity of adequate and proper treatment to save what is left of an injured hand is given. The author advocates early closure of the wound when possible, as an intact integument is essential to save damaged nerves, tendons and bones. Nerves and tendons should be repaired primarily if possible. The fractures should be considered secondarily to soft tissue injuries in most instances. Skeletal traction is advocated in preference to so-called pulp traction.

Early roentgen studies of injuries of the wrist will often locate fractures of the carpal scaphoid. Immobilization in plaster of paris should not include portions of the hand not involved in the injury. The role of physical therapy and the restoration of the hand are discussed.

A general survey of army methods of handling war injuries of the hand is presented by Bruner.⁵⁸² He comments on the early closure of wounds in foreign theaters and stresses the importance of correct splinting, physical therapy and occupational therapy in rehabilitation. The special procedure necessary for treating injuries of the skin, nerve, bone, joint and tendon is discussed.

Many more extensive procedures, such as shifting of fingers and pollicization, are commented on.

After a discussion of treatment for septic infections of the hands and fingers, the indications for conservative and radical surgical intervention

580. Schaubel, H. J., and Smith, E. W.: Splint for Treatment of Mallet Finger, *J. Bone & Joint Surg.* 28:394-395 (April) 1946.

581. Cleveland, M.: Saving the Injured Hand, *New York Med.* 2:19-22 (Sept. 5) 1946.

582. Bruner, J. M.: Treatment of War Injuries of Hand in U. S. Army, *J. Iowa M. Soc.* 36:509-511 (Dec.) 1946.

in these regions are presented by Stonham.⁵⁸³ The technic for amputation of a finger is described. In the presence of infection, disarticulation is preferable to section of the bone. The observations pertain especially to war wounds.

A simple method for extracting fish hooks is described, in which the hook, guided by a scalpel blade, is drawn out through the passage of entrance. Sepsis often develops and must be watched for so that early chemotherapy can be instituted. In cases of diphtheroid infection the author administers antitoxin and applies bismuth iodoform paraffin paste or actual cautery.

For burns of the fingers and hand, the author has found tanning to give good results. In severe cases various methods for grafting may be used.

[ED. NOTE.—The advisability of tanning in cases of burns involving flexor or extensor creases is questionable.]

Mason⁵⁸⁴ presents a rather comprehensive article on the subject of primary and secondary repair of nerves and tendons. The first principle stressed is that of protection against further trauma and the second that of protection against contamination of the wound, soap and water cleansing of the skin and closure of the wounds to prevent further contamination. He advocates the use of a prepared metal splint which conforms to the configuration of the hand. He gives a four hour limit for primary closure in repair of tendons and a six to eight hour limit for closure in repair of nerves. He feels that it is unwise to suture beneath flaps or grafts. Secondary repairs should be done only after all induration is gone. He is not in favor of putting in artificial membranes to form sheaths or to replace tendons.

Koch⁵⁸⁵ divides the treatment of tendons and nerves of the hand into that given immediately after injury and that given after healing of the wound is complete. If primary suturing is to be done, the condition must be satisfactory so that primary healing will occur. Secondly, whether or not the repair is early or late anatomic restoration is of great importance. It is far better to err on the conservative side than to attempt to do too much. It is felt that the local medication is detrimental to primary healing of the tendon. A few points of the technic of suturing the nerves and tendons are presented. When the tendon is frozen in a digital sheath, there is no adequate method of repair or freeing. A complete tendon graft is necessary. The use of a plasma clot in repair

583. Stonham, F. V.: Some Observations on Surgery of Hand, *Indian M. Gaz.* 80:597-601 (Dec.) 1945.

584. Mason, M. L.: Injuries to Hand, with Particular Reference to Indications for Primary and Secondary Nerve and Tendon Repair, *J. Oklahoma M. A.* 39:246-251 (June) 1946.

585. Koch, S. L.: Injuries of Nerves and Tendons of Hand, *Cincinnati J. Med.* 27:515-521 (Aug.) 1946.

of nerves is discussed, and it is the author's belief that it is not satisfactory, particularly in the cases of secondary healing.

In regard to gliding materials in tendon work, it is believed that gelatin, cellophane or amniotic fluid have little or no value. The ideal gliding material is soft areolar tissue. The importance of not having tension on the tendon and nerve sutures is stressed.

An extensive article on the general consideration and treatment of injuries of the hand and on the reconstructive surgical procedures and the general principles necessary for restoration of the function of the hand is presented by Moore⁵⁸⁶. The importance of a detailed original examination and of follow-up care is stressed. The type of treatment is influenced by the occupation of the patient.

There must be a complete and adequate skin covering and complete mobilization of joints before reconstructive surgical treatment is instituted. The author contends that arthroplasty and other procedures should not be combined with repairs of tendons. Repair of a tendon should be done prior to point surgical intervention on the joint. He advises the use of dorsal splints for repair of volar tendons and the use of volar splints for repair of dorsal tendons; the splinting should not include portions of the hands not undergoing operative procedure. The importance of detailed occupational therapy is stressed. He enumerates a number of mistakes made in the surgical treatment of the hand, which include (1) prolonged immobilization, (2) forceful manipulation under anesthesia, (3) allowing exposed areas to heal by granulation, (4) failure to operate with a tourniquet and (5) failure to have adequate tools to perform the delicate operation indicated.

He feels that a finger with stiff joints and with injuries to the nerves and tendons is an indication for amputation and not for reconstruction.

A number of cases in which there was severe damage to the bones of the hand are presented by Snedecor.⁵⁸⁷ A general discussion of various possibilities of reconstruction is presented. He prefers fixation of bone grafts with Kirschner's wires.

A case in which total carpectomy was carried out for release of Volkmann's contracture is presented.

A general written discussion regarding traumatic lesions of the hand is presented by Gonzalez Garcia.⁵⁸⁸ He stresses the need for immediate

586. Moore, F. T.: Discussion on Treatment of Injuries to Hand, *Brit. J. Surg.* **34**:70-74 (July) 1946.

587. Snedecor, S. T.: Bone Surgery of Hand, *Am. J. Surg.* **72**:363-372 (Sept.) 1946.

588. Gonzalez Garcia, A.: Estadísticas traumatológicas, *J. Internat. Coll. Surgeons* **9**:506-508 (July-Aug.) 1946.

early care and observes that the left hand is more often injured than the right, particularly in workers on sugar cane plantations.

Stenosing Tenosynovitis and Tendinitis.—Rose⁵⁸⁹ presents 2 cases of so-called trigger thumb in infants aged 9 months and 2 years respectively. In a general discussion he states that the lesion is first localized in the tendon sheath and that the changes in the tendon are secondary. The pathologic process is similar to that in adults.

His patients are treated by incision of the sheath to relieve the constriction. Prognosis is considered good, and recurrence is rare. The condition may be present from birth, and a small movable swelling appears at the base of the thumb. In the case reported the nodules on the tendon did not decrease in size.

Lasserre⁵⁹⁰ has changed the name of "trigger finger" to that of "spring finger," and he presents a simple method of preventing the finger from snapping into complete flexion. He has devised a ring with the signate part anterior for the purpose of preventing the finger from going into complete flexion. He states that this gives sufficient block to the finger to prevent the nodule on the tendon from passing beneath the arc of the digital sheath. This simple method is indicated before surgical intervention.

An interesting article on calcareous tendinitis of the flexor tendon of a finger is presented by Vasko.⁵⁹¹ In a general discussion he states that calcification takes place in various tendon tissues of the body. The etiology is still uncertain. Some authors feel that it is due to trauma and others that it is a metabolic disturbance and is due to a deficiency of vitamin E. Treatment of such calcifications varies, surgical removal, diathermy, administration of salicylates, roentgen therapy, irrigation, injections of procaine hydrochloride or the administration of vitamin E being employed.

A case is reported in which the right middle finger of a 28 year old man was involved. The onset was gradual. The roentgenogram revealed considerable saucer-shaped calcifications lying in the soft tissue anterior and proximal to the distal interphalangeal joint. There was a spontaneous disappearance of the calcifications, swelling and pain. The only treatment employed was splinting.

A case of a 38 year old woman with radial palsy as a result of a gunshot wound is presented by Poinot.⁵⁹² An attempt at nerve suture resulted in secondary suppuration and failure.

589 Rose, T. F.: *Bilateral Trigger Thumb in Infants*, M. J. Australia **1**:18-20 (Jan. 5) 1946.

590. Lasserre, C.: *Un traitement simple du doigt à ressort*, J. de méd. de Bordeaux **121-122**:375-376 (July) 1945.

591 Vasko, J. R.: *Calcareous Tendinitis of Flexor Tendon of Finger: Report of Case*, J. Bone & Joint Surg **28**:638-640 (July) 1946.

592. Poinot, J.: *Paralysie radiale, tenoplastie des extenseurs*, Bordeaux chir. **3-4**:148-149 (July-Oct.) 1945.

Eight months after injury transplantation of the flexors of the wrist and the palmaris longus to replace the extensors of fingers and wrist was done, the palmaris longus being used to extend the thumb. The hand was splinted in extension for twenty days. Eight months after surgical treatment the patient had normal extension of all fingers.

The author states that a similar operation was performed in 3 other cases, with excellent results.

A similar case of radial palsy was reported by Charbonnel and Barroux.⁵⁹³ In this case the palmaris longus, as well as the wrist flexors, was transplanted. Splinting for a period of four months was carried out. The patient apparently had suffered considerable other damage to the nerves. No final analysis of the case was presented.

An excellent and extensive article by Zachary⁵⁹⁴ on a follow-up of transplants for radial paralysis is presented. According to this author, the persistent assertion in the papers reviewed that failures were due to defective postoperative care strongly suggests that failures are by no means uncommon. Because of this, a review of the cases at the Winfield Morris Hospital from 1940 to 1945 was undertaken. Fifty-seven cases were reviewed, and a rather critical analysis of results was made.

The author worked out a system whereby a loss of each 10 degrees of extension of the fingers was rated as a negative 10 per cent. Flexion and extension of the wrist were also put on a percentage basis. He presented an extensive table of individual cases classified according to the transplant and the result. In transplants for radial paralysis, it is important to preserve active flexion to stabilize the wrist, and failure to take this precaution often leads to incomplete extension of the fingers and unnecessarily weakens or abolishes the power of the wrist flexor. He advocates leaving the flexor carpi radialis to flex the wrist.

A standard method for testing the result of tendon transplant for radial paralysis is suggested and illustrated.

Guilleminet and Dubost⁵⁹⁵ present a case of severe obstetric paralysis with the classic deformity of internal rotation and radial paralysis. The problem considered was that of correcting the position of internal rotation and wrist drop to restore adequate digital extension. A rotation osteotomy was done, followed by a transplantation of the flexors of the wrist to extend the fingers and wrist. An extensive discussion of the case and of other possibilities is given by the author.

593. Charbonnel and Barroux, R.: Transplantations tendineuses pour paralysie radiale définitive, *Bordeaux chir.* **1-2**:55 (Jan.-April) 1944.

594. Zachary, R. B.: Tendon-Transplantation for Radial Paralysis, *Brit. J. Surg.* **33**:358-364 (April) 1946.

595. Guilleminet, M., and Dubost, T.: Un cas de traitement de la paralysie des extenseurs des doigts et de la main par transplantation tendineuse chez un enfant de cinq ans, *Rev. d'orthop.* **32**:72-75 (Jan.-April) 1946.

Five cases of rupture of the extensor pollicis longus tendon following Colles' fracture are presented by Smith.⁵⁹⁶ In a review of the literature presented, he states that the first case was reported by Duplay in 1876. He considers the condition to be due to injury of the tendon by a spicule of bone or to chronic tenosynovitis possibly interfering with the blood supply. Often there are no preliminary symptoms, and the first finding is the drooping of the thumb. The site of the rupture is usually at Lister's tubercle. The average time from the fracture to the time of rupture is twenty-nine days.

The dual function of the extensor pollicis longus is discussed. The author holds that the extensor function is less important than the prevention of the droop by the oblique pull of the tendon on the thumb. The direction of pull is extremely important. The method of repair effected is that of suturing the extensor pollicis longus to the extensor carpi radialis longus. The extensor pollicis brevis is also sutured to the distal stump in a side to side manner.

A case of bilateral ruptured extensor pollicis longus tendon is presented by Jorgensen.⁵⁹⁷ The patient was a man, 33 years old, who was suffering from diabetes mellitus which was well under control. With no history of trauma, there developed on both wrists an inflammatory degenerative process at the site of predilection for rupture of the extensor pollicis longus. After a few years, a bilateral rupture occurred, one side being treated surgically.

In his report, May⁵⁹⁸ states that tendon transplantation is the free grafting of a tendon for the purpose of filling a tendon defect or replacing a destroyed tendon. If the defect is due to infection, a delay of three months, with the use of penicillin, is necessary. The author favors removal of the paratenon with the tendon to be transplanted. This aids in the early activation of the tendon. He stresses the point that a stiff joint is a strict contraindication to any repair of the tendon unless mobilization is possible by physical therapy or operative manipulation.

He prefers operating in a bloodless field and describes incisions which are more or less accepted at the present time. He feels that a primary tendon suture should be attempted only in the most favorable circumstances, that primary sutures should not be done as a rule and that a secondary graft is usually indicated. If both flexors of the tendons of the finger are cut, only the profundus is sutured.

596. Smith, F. M.: Late Rupture of Extensor Pollicis Longus Tendon Following Colles's Fracture, *J. Bone & Joint Surg.* **28**:49-59 (Jan.) 1946.

597. Jorgensen, G.: Case of Bilateral Spontaneous Rupture of Extensor Pollicis Longus Tendon, *Ugesk. f. læger* **107**:506-507 (June 28) 1945.

598. May, H.: Tendon Transplantation in Hand, *Surg., Gynec. & Obst.* **83**: 631-638 (Nov.) 1946.

The author presents a new splint, which appears to be satisfactory, for the immobilization of individual joints.

A case of a patient, 40 years old, who suffered a dislocation of the tendon of the extensor carpi ulnaris muscle is presented by Obrant.⁵⁹⁹ Examination revealed a dislocation of the tendon on the ulnar volar aspect. The tendon sheath here formed a sac, which was incised, and its volar and dorsal margins were sutured to bring the sheath to normal position. The hand was then immobilized in slight flexion. After twelve days exercises were begun, and two weeks later the patient was discharged in good condition.

[ED. NOTE.—Two weeks is not sufficient time for tendons and ligaments to heal sufficiently to withstand stress.]

Webster⁶⁰⁰ describes the reason for poor results of the primary tendon suture as being anatomic, bacterial and surgical. The benefit of the "straight-line" pull of the extensor tendon over the metacarpals and of a "straight-line" pull of the flexor tendon to the wrist and palm of the hand is stressed. The "around the corner pull" of the flexors of the finger is mentioned as well as the fact that the flexor tendon necessarily passes through the synovial sheath and tunnel which resists the normal gliding of the tendon. The necessity of adequate surgical technic to prevent bacterial introduction is also brought out. The errors of improper and poor surgical technic and judgment and of the improper incision which leads to failure are stressed. The author mentions that tendons with stiffness of the distal joints should not be repaired.

A general discussion on the various problems and the after-care through the period of immobilization is presented. It is also stressed that cooperation of the patient must be excellent if good results are to be obtained. Good results are frequent, but excellent results are rare.

Kestler⁶⁰¹ reported a case in which there was recurrent dislocation of the first carpometacarpal joint. An operative procedure was described which consisted of taking the extensor pollicis brevis distal to the dislocated joint and transplanting it through the holes in the first metacarpal and greater multangular bones. The capsule was then closed and the distal portion of the tendon sutured back to the proximal end of the tendon. It is the author's contention that function of the muscles is adequate to hold the involved bone in place.

599. Obrant, O.: Case of Dislocation of Tendon of Extensor Carpi Ulnaris Muscle, *Nord. med.* **29**:656 (March 22) 1946.

600. Webster, G. V.: Late Repair of Tendons in Hand, *Am. J. Surg.* **72**:171-178 (Aug.) 1946.

601. Kestler, O. C.: Recurrent Dislocation of First Carpometacarpal Joint Repaired by Functional Tenodesis, *J. Bone & Joint Surg.* **28**:858-861 (Oct.) 1946.

A new operation for treatment of habitual dislocation of the proximal phalanx of the thumb is presented by von Stapelmohr.⁶⁰² Splendid results were obtained in 2 cases. After radial and ulnar incision at the level of the basal joint, the tendons of the abductor flexor and the adductor pollicis brevis are exposed and drawn together by a cuff of transplanted fascia lata.

Splinting and Rehabilitation.—Many types of extremely satisfactory splints are presented by Bunnell⁶⁰³ The article is well illustrated, and the principle of each splint is stressed.

He presents a "cock-up" splint for the wrist, various traction splints for the metacarpal joints and a so-called knuckle-bender splint which is operated by elastic traction for the metacarpophalangeal joints. Most of these splints are operated by spring or rubber band traction which aids in the correction of deformities of the fingers, wrists and hands. He presents an adequate splint for practically any condition of the hand. This is a useful article on splinting of the hand to overcome various contractures and deformities. Bunnell⁶⁰⁴ presented another article devoted entirely to the "knuckle-bender" splint. He stresses the instances in which the splint is indicated and states that it corrects the deformity from muscle imbalance of both the median and the ulnar nerves. A discussion of the principle and the function of the splint is presented as well as a detailed method of construction. The flexion can be controlled by the number or the strength of the rubber bands.

A splint to correct and prevent deformity in paralysis of the ulnar nerves is presented by Pruce.⁶⁰⁵ The splint is made with a soft leather cuff which circles the proximal phalanges and is attached to a leather wristlet by a rubber band. It is left in place until there is either full recovery or no hope for further improvement. It is of no value in established claw deformity with secondary contracture of the joints and is useless in cases in which there is a broken transverse metacarpal arch of involved digits. Further observation is needed for final evaluation.

Lefkoe⁶⁰⁶ states that injuries of the hand and fingers are beginning to assume their true importance in the surgeon's vista. In 1941, 77 per cent of all permanent impairments in the field of manufacturing involved

602. von Stapelmohr, S.: Operation for Habitual Luxation of Thumb, *Acta chir. Scandinav.* **94**:379-382, 1946.

603. Bunnell, S.: Active Splinting of Hand, *J. Bone & Joint Surg.* **28**:732-736 (Oct.) 1946.

604. Bunnell, S.: Knuckle Bender Splint, *Bull. U. S. Army M. Dept.* **5**:230-231 (Feb.) 1946.

605. Pruce, A. M.: Splint to Correct Deformity Resulting from Injury to Ulnar Nerve, *J. Bone & Joint Surg.* **28**:397 (April) 1946.

606. Lefkoe, H.: Rapid Rehabilitation Following Hand Injuries, *Arch. Phys. Med.* **27**:499-508 (Aug.) 1946.

the hand. He discusses the point that surgical treatment of the hand is no longer considered "minor surgery" but is in the "major surgery" field.

There are a tremendous number of papers covering the surgical technic of operations on the hand, but there are extremely few on the definitive surgical treatment. The author feels that physical therapy apparently includes all fields of physical medicine. He is opposed to early readaptation of the patient to his former work, as it promotes substitution by the patient.

Brachial block is considered to be the anesthesia of choice, and operations are done under tourniquet. Early closure of wounds of the hand is stressed, and the importance of the pressure dressing is brought out. Sensitive skin grafts as complications of stumps of fingers are treated with tannic acid solution to toughen the skin. Immobilization should not include parts which are not involved. The importance of early motion after fractures is emphasized, and he states that excellent anatomic position is a poor substitute for function. The importance of the use of procaine hydrochloride intravenously is stressed. He brings out that a muscle, to be transposed, should be of good power and that redevelopment of the muscle power can be obtained only by mobilization plus coordination. He stresses the importance of individual muscle training in preference to group muscle training.

A discussion of the relative merits of paraffin baths as compared with those of infra-red radial heat is given. The physiopathic syndrome of the swellers and nonswellers is attributed to a constitutional inferiority of the neurovascular system.

Pearlman⁶⁰⁷ advocates the wrapping of adherent flexor tendons with a fine tantalum foil. After the tendon is wrapped with the foil, motion is instituted in three or four days. The tantalum is wrapped completely around the tendon, and the tendon is dropped back into the normal channel. Heavy foil is contraindicated, as it will often move and may cause pressure necrosis of the skin.

[ED. NOTE.—I question the advisability of completely surrounding the tendon with any impermeable membrane, as the tendon is kept alive by adjacent body fluids.]

Reconstruction of the Thumb and Fingers.—A general consideration of the methods and problems encountered in reconstruction of the thumb is presented by Greeley.⁶⁰⁸ He states that there are four methods of physiologic reconstruction to be considered: (1) deepening of the thumb web, (2) pollicization of the remaining partial finger, (3) replace-

607. Pearlman, R. C.: Use of Tantalum in Tendon Reconstruction of the Hand, U. S. Nav. M. Bull. **46**:1647-1650 (Nov.) 1946.

608. Greeley, P. W.: Reconstruction of Thumb, Ann. Surg. **124**:60-70 (July) 1946.

ment with a toe and (4) lengthening of the missing thumb stump. Pollicization of the index finger should be reserved for persons with subtotal loss of the index finger.

The author constructed ten thumbs by forming a tube pedicle graft of skin and inserting a bone graft for the stabilizing portion. The use of tibia, iliac crest and twelfth rib was tried. A complete discussion of the technic employed is presented.

The first complication mentioned by the author was a breakdown of the pedicle at the distal end. The second complication was that of infection and necrosis of the bone graft, and the third was a green stub fracture of the graft. He states that all types of sensation except stereognosis developed in the transplanted skin flap, the time required for this varying from six months to two years.

A case is presented by Beardsley and Zecchino⁶⁰⁹ in which a thumb is reconstructed from an abdominal flap. The reconstruction was carried out in four stages.

In the first stage a tube was formed on the abdomen and a tibial bone graft transplanted into the formed tube. In the second and third stages the tube was attached to the hand. The fourth stage consisted in dividing the pedicle and shaping the thumb. The authors felt that the cosmetic result justified the surgical procedure.

Morandi⁶¹⁰ reviews the literature on methods of reconstruction of the thumb and reports 15 cases. In 2 cases freezing was the cause of injury and in the remainder explosion of hand grenades and similar incidents. In 2 cases there remained a small residual stump of the thumb which was of no practical use for grasping. The effect of the type and degree of injury on function is discussed. He presents methods of phalangization.

If an attempt is made to deepen the interspace between the first and second metacarpals, one will have to await secondary healing in the proximal portion of the wound because of dearth of the skin flaps. Removal of the second and third metacarpals permits opposing skin flaps and complete closure. Functional results of phalangization following physical therapy which begins the third week after operation are excellent.

In cases in which amputation of the finger from the radial side of the hand, so common in war surgery, has been carried out, a portion of the basal phalanx of the thumb remains and removal of the second metacarpal will be found of great advantage. If the thumb is disarticulated

609. Beardsley, J. M., and Zecchino, V.: Reconstruction of Thumb, *Am. J. Surg.* **71**:825-827 (June) 1946.

610. Morandi, G.: Indicazioni e risultati della ricostruzione chirurgica del pollice, *Chir. d. org. di movimento* **30**:41-51 (Jan.-March) 1946.

to the metacarpophalangea or if the distal epiphysis of the first metacarpal is also destroyed, the second and third metacarpals should be removed, since this allows better function.

Young⁶¹¹ states that the first work in transplanting toes for fingers was done by Nicoladoni. His first report was in 1900—that of the substitution of a part of the second toe for a partial defect of the thumb. In the same year Von Eiselsberg reported restoration of the index finger.

The literature on the subject was reviewed. A case is reported in which the second toe was transplanted to replace the loss of the distal portion of the index finger. The distal two phalanges of the toe were transplanted, which resulted in no motion of the distal joint, coloring and sensation having returned to the level of the nail bed.

[ED. NOTE.—It would appear that the benefit of this operation is purely cosmetic.]

Restoration of a missing thumb in 2 cases by transplantation of the index finger is reported by Kelikian and Bintcliffe.⁶¹² In both cases there were partial damage to the index finger and loss of the thumb. The cleft between the transplanted index finger and the middle finger was formed by an abdominal pedicle flap. There was an attempt to preserve the nerve and arterial supply of the index finger as well as the function of the flexor and extensor tendons. The authors' criterion for a successfully reconstructed thumb was a thumb that would move out and in the oppositional position, abduct, flex and touch the other finger tips. It must be able to feel and to distinguish between hot and cold and to convey some awareness of shape and position.

A rather extensive report of the operative procedure is presented, as well as a discussion of variations and short cuts which might be considered.

Records of 517 cases in which lost fingers or thumbs were replaced by plastic methods were collected by Parin.⁶¹³ He presented 202 of his own cases in which treatment was carried out for loss of fingers as a result of wounds, frostbite and congenital anomalies. In some reconstructive procedures were carried out, and many of his results are shown in photographs.

He states that phalangization of the first metacarpal is presented in a few cases, three to five of the metacarpals being phalangized. Pollicization of the index finger was carried out. Transplantation of the finger from the opposite hand to replace a lost thumb was also carried out, the ring finger of the opposite hand being used for the transplant.

611. Young, F.: Transplantation of Toes for Fingers, *Surgery* 20:117-123 (July) 1946.

612. Kelikian, H., and Bintcliffe, E. W.: Functional Restoration of Thumb: Pollicization of the Index, *Surg., Gynec. & Obst.* 83:807-814 (Dec.) 1946.

613. Parin, B. V.: Reconstruction of Fingers, abstracted, *Bull. War Med.* 6: 524 (Aug.) 1946.

In transplanting toes to the hand, the author closely followed the technic described by Nicoladoni, the second and third toes being used for the transplant. He describes a case in which four toes were transplanted simultaneously to replace fingers.

Kallio ⁶¹⁴ states that in spite of the disability and inconvenience caused by the absence of a thumb a review of the literature does not give the impression that much attention has been given to plastic procedures for surgical corrections.

The author presents a series of 10 cases which he divides into two groups according to whether the material for plastic replacement was taken from the immediate adjacent tissues of the hand or transplanted from other parts of the body. The method of using remote flaps was applied in 5 cases. The transplanted bone in the skin tube was absorbed in 4 cases, which necessitated repeated transplantation of bone. In regard to sensibility, mobility and strength, the thumbs produced were most satisfactory. With the exception of the ends, they were sensitive to touch and pinprick, and four were even sensitive to heat.

In 1 case in which the thumb and the first metacarpal joint were missing excellent results were obtained by a means of a distant plastic procedure performed in three stages. In the second stage a free bone graft was inserted directly into the multangulum majus and, after fixation, introduced into a skin tube formed from abdominal skin at the first stage. This tube was then sutured to the hand. It is suggested that in the estimation of disability for compensation claims, this should be judged as being from 10 to 15 per cent higher when the first metacarpal is missing. Plastic operations are capable of reducing this disability by 5 to 10 per cent.

Dislocations of Wrist.—Martinez Correa ⁶¹⁵ presents 7 cases of severe lesion of the distal portion of the forearm and wrist. In the majority healing was by radiocarpal ankylosis, which necessitated resection of a segment of the ulna to obtain prosupination movements. He discusses the complex physiology of these movements, including rotation of the radius around an immovable ulna and rotation by simultaneous displacement of the two bones of the forearm; which is much more complex. Total or partial loss of supination is much more important from a functional point of view than limitation or loss of pronation, which is easily compensated by pronation of the shoulder.

The 7 cases are described in detail. Radiocarpal arthritis was followed by ankylosis in 2 cases and sequestration of the distal epiphysis

614. Kallio, K. E.: Sur les operations plastiques du pouce, *Acta chir. Scandinav.* 93:231-253, 1946.

615. Martinez Correa, B.: La resección cubital y la recuperación de la prosupinación, *Arch. Soc. cirujanos hosp.* 15:798-803 (Dec.) 1945.

of the ulna in 1. Of 3 cases involving older patients, radiocarpal arthritis developed in the first, a comminuted fracture healed with the distal epiphysis of the radius in the wrong position in the second and in the third there was synostosis. Prosupination was lost in all cases. To restore pronation, the inferior extremity of the ulna was resected. In 1 case ulnar resection was not necessary because a pseudarthrosis in the ulna acted in the same way as a resection in favoring rotatory movements of the forearm. There was no pain, and no reduction in power occurred. Any operation to obviate pseudarthrosis is superfluous and dangerous. All patients except 1, who was still under treatment, recovered prosupination in spite of extremely severe bony lesions and also, in some cases, extensive injury to the soft parts. Ulnar resection is a simple operation and can be done under local or plexus anesthesia.

An article by Sutro⁶¹⁶ states that one of the unusual causes of painful snapping or clicking of the wrist is a recurrent subluxation in the intercarpal region. Two cases are presented in which subluxation was produced by a strong active flexion of the fingers or hand.

As a basis of investigation, twelve pairs of normal wrists were observed and roentgenograms taken with the wrists in the neutral attitude, in dorsal flexion and in palmar flexion. Sutro felt that in the 12 cases a minimal anterior subluxation of the distocarpal bones could be produced. In 1 of the 2 cases presented an arthrodesis was performed between the left capitate lunate and navicular bones because of frequent episodes of pain and swelling. A complete disappearance of pain and swelling followed the fusion. It is his opinion that the basis of a recurrent intercarpal subluxation is an overlengthening of the ligaments binding the carpal bone, which imbalances the power between the flexor and the extensor apparatus of the fingers and hand.

A case of backward dislocation of the head of the ulna is presented by Masmonteil and Leuret.⁶¹⁷ A surgical technic described for treatment consists essentially of fixation of the ulnar head in the radius and institution of a pseudarthrosis in the lower third of the ulna by osteotomy and muscle interposition, which permits a rotation of the ulna. This rotation must take place above the inferior margin of the interosseous ligament so that the upper portion of the ulna remains normally fixed to the radius. The results of this method were reported as perfect.

An illustrative case is described in which a girl of 17 years had fractured her wrist. She was able to use her hand on the tenth day,

616. Sutro, C. J.: Bilateral Recurrent Intercarpal Subluxation, *Am. J. Surg.* **72**:110-113 (July) 1946.

617. Masmonteil, F., and Leuret, J.: Luxation de la tete cubitale en arriere: Traitement par l'operation de Sauve et Kapandji (2^e maniere), *Mém. Acad. de chir.* **72**:353-355 (June 19-26) 1946.

and by the twentieth day function, which had been lost for five years, was restored.

Tranquilli-Leali⁶¹⁸ presents a report in which he states that the course of dislocation of the wrist is usually that of an extremely long period of recovery, with late cicatrization of the serious periarticular lesions. Retrolunar dislocation of the wrist without fracture can be reduced without operation some hours after injury and causes invalidism for from forty to fifty days. Sixty to seventy days may be required if the dislocation affects the volar or dorsal aspect of the semilunar bone. If the lunar and perilunar dislocations are complicated by fracture of the wrist or radioulnar fracture, the course is doubled because of carpus callus.

Among 77 cases, there were from 100 to 80 per cent good results in 15, from 80 to 60 per cent good results in 30, from 60 to 40 per cent good results in 22 and poor results in 10. In 9 of these 10 cases old dislocations were present. Prognosis is somewhat influenced by the age, the general condition and the site and type of the dislocation. Conservative treatment should be applied at the earliest possible moment. The longer treatment is delayed, the less perfectly will function be restored.

Curr and Coe⁶¹⁹ present 4 cases of dislocation of the inferior radio-ulnar joint, in 1 of which there was dislocation of the proximal and distal joints and in another dislocation of the scaphoid and ulnar joints. Roentgenograms are shown and individual case histories presented. The case of dislocation of the proximal and distal radioulnar joints required open reduction and resulted in almost complete loss of pronation and supination. In the other cases closed reduction was employed, and it produced satisfying results.

An unusual case of dislocation of the scaphoid on the radius is presented. The condition was treated by closed reduction, with a satisfactory realinement of the bone.

A review of portions of the literature and a general discussion followed.

Pygott⁶²⁰ reported 331 cases of recent injury to bones of the wrist region; 2 of the patients had bilateral injuries. He classified all the injuries and reported the following figures: Fracture of the distal radius occurred in 42 per cent of cases, in 10 per cent of which true Colles'

618. Tranquilli-Leali, E.: *Decorso esiti e prognosi delle lussazioni carpiche*, Arch. ortop. **57**:163-196 (March) 1942.

619. Curr, J. F., and Coe, W. A.: *Dislocation of Inferior Radio-Ulnar Joint*, Brit. J. Surg. **34**:74-77 (July) 1946.

620. Pygott, F.: *Wrist Injuries in Service Patients*, Brit. J. Radiol. **19**:381-382 (Sept.) 1946.

fracture was present, scaphoid fracture in 34 per cent, combined radius and scaphoid fracture in 4 per cent, carpal dislocation in 3 per cent and Bennett's fracture in 9 per cent. Five patients with Kienböck's disease were seen because of pain, but none had fracture.

Roegholt⁶²¹ states that "epicondylalgia" is the correct name for pain and discomfort in the lateral epicondyle and that the condition should not be called "epicondylitis" as no inflammatory process can be demonstrated. Pain in the same region may be caused by such conditions as bursitis and arthritis. Epicondylalgia occurs most frequently in men, especially in laborers who are employed all day in monotonous operations such as hanging clothes, dressing hair, loading trucks or hammering constantly.

In the attempt to determine the cause of this condition, the author made a careful anatomic study of the region in dissected elbows. He draws attention to a tendinofascial bundle inserted at the anterior and inferior margins of the epicondyle. Traction on this structure causes pain. As a curative measure, he suggests transverse incision of this structure $2\frac{1}{2}$ fingerbreadths below the epicondyle. The skin is sutured, and pain is relieved. The patient can resume work after fourteen days.

Stack and Hunt⁶²² state that so-called tennis elbow is due to various lesions around this joint. Synonymous terms frequently seen in medical writings are epicondylitis, epicondylalgia, radiohumeral bursitis and radiohumeral synovitis. They state that "tennis elbow" covers a multitude of various situations and is not an exact diagnosis.

A sketch which reveals the points of tenderness is shown, and a test for using the hand in pronation and supination in the process of lifting is also discussed. While there is little or no discomfort when lifting with the hand in supination, there is tremendous pain when lifting with the hand in pronation.

If the condition does not respond to the usual conservative treatment such as splinting, diathermy and application of local heat, it is probable that there is radiohumeral synovitis present. The authors recommend open operation, with excision of redundant synovial tissue.

Pathologic Conditions Involving the Vasomotor Mechanism and Volkmann Contracture.—A general discussion of Volkmann contracture is given by Clarke.⁶²³ He states that the accepted theory is that venous obstruction causes hemorrhage along the muscle fibers followed by an acute inflammatory reaction and later by diffuse fibrosis. The theory

621. Roegholt, M. N.: Epicondylalgia, *Nederl. tijdschr. v. geneesk.* **90**:50-51 (Jan. 19-26) 1946.

622. Stack, J. K., and Hunt, W. S.: Radio-Humeral Synovitis, *Quart. Bull., Northwestern Univ. M. School* **20**:394-397, 1946.

623. Clarke, W. T.: Volkmann's Ischaemic Contracture, *Canad. M. A. J.* **54**: 339-341 (April) 1946.

of arterial ischemia in which there are massive necrosis and fibrosis of the muscle is also discussed. An investigation of the conflicting views was carried out.

Considerable experimental work was done in which dogs were used and blood pressure cuffs applied to produce stasis. The muscles were also traumatized. Another group of dogs was treated by ligation of the arteries. The author's conclusion was that the condition could easily have either arterial or a venous origin but that it was more probably a result of arterial ischemia. He expressed the belief that ischemia is not due to a tight cast and that the success of early treatment lies in realizing the possibility that arterial obstruction is the cause of contractures.

Ball⁶²⁴ states that the conception of Volkmann contracture was that it was due to a continuous stoppage of arterial blood. The modern conception is one of venous obstruction and a sequence of tight bandaging and splinting.

A case is reported in which a severe Volkmann contracture occurred as the result of an untreated fracture of the olecranon without displacement. The injury occurred at midnight, and by 11 a. m. the arm was tense, swollen and painful. Complete anesthesia was present from just above the wrist joint to the ends of the fingers. The swelling in the forearm did not involve the hand, but there was complete paralysis of the muscles of the forearm and the hand. Radial and ulnar pulses were palpable and of good volume. Surgical exploration in which the tension of the muscles was freed was carried out. A severe deformity and contracture developed in spite of treatment.

There are 3 other case reports on Volkmann contracture. Marino⁶²⁵ reports a case of contracture following a supracondylar fracture. He suggests an operative procedure in which a broad incision, with splitting of the aponeurosis, is done and the median and cubital nerves are examined and liberated through their course. Periarterial sympathectomy was performed on the radial and cubital arteries. A Mommensen apparatus was employed to relieve the contractures.

In de Leo's case⁶²⁶ the condition was secondary to a wound on the forearm. He also performed periarterial sympathectomy of the humeral artery and freed the muscles. Elastic traction was used to relieve the contracture. He states that functional results after seven months were not encouraging.

624. Ball, L.: Volkmann's Ischaemic Contracture of Forearm, M. J. Australia **1**:224-225 (Feb. 16) 1946.

625. Marino, H.: Retraccion isquemica de Volkmann; incision exploradora, operacion descomprensiva, Prensa méd. argent. **32**:2413-2415 (Dec. 7) 1945.

626. de Leo, F.: Contributo alla patogenesi della malattia di Volkmann, Chir. d. org. di movimento **30**:90-105 (Jan.-March) 1946.

The danger of hemostatic bandages (Esmarch bandages) is stressed by Mester.⁶²⁷ He feels that the so-called tourniquet may, under war conditions, lead to fatal shock and severe anaerobic infections and that the use of such bandages should be avoided whenever possible. It is impossible to check and control the tourniquet adequately, and an Esmarch bandage which has been on more than two hours should be removed in stages so that the patient is given a better chance to neutralize liberated toxins. Local pressure dressings are considered to be far superior.

Dupuytren's Contracture.—Desplas and Tostivint⁶²⁸ reported on a series of 107 patients; 150 hands and 120 operations were involved. After a general discussion of the etiologic and pathologic factors in Dupuytren's disease, the authors recommend the performance of a partial aponeurectomy when possible. They consider total intervention unjustifiable in the treatment of contractures of limited extent. They do stipulate, however, that all pathologic tissue must be removed. Frequently it is the cutaneous infiltration rather than the too conservative operation which leads to failure. Cutaneous defects can be filled in by various methods of grafting. The technic is planned to fit four types of defects: (1) localized palmar nodule or unidigital or paucidigital cord under a relatively normal skin—a partial aponeurectomy is indicated; (2) localized type, with considerable cutaneous infiltration—a partial aponeurectomy is indicated, with excision of the diseased skin followed by a dermal-epidermal graft; (3) extensive involvement under normal skin—since the radial portion of the aponeurosis is usually intact, wide but not total aponeurectomy is indicated, with conservative treatment of the skin (bridge flap), and (4) extensive involvement, with pronounced infiltration of the skin—wide aponeurectomy is indicated, with excision of the diseased skin followed by grafts.

Results were mediocre in 26 cases and poor in 6. Partial or full recurrence may be expected in a certain proportion of cases. General anesthesia is preferable. Extremely sharp, small instruments should be used to avoid laceration. Details of technic are described. After operation there should be no hyperextension; rather the fingers should be in a flexed position.

A series of 111 patients with Dupuytren's contracture, including 101 men and 10 women, is presented by Einarsson.⁶²⁹ The average

627. Mester, Z.: Ueber die Gefahren der blutstillenden Gliederabschnurung, Schweiz. med. Wchnschr. **75**:1033-1035 (Nov. 24) 1945.

628. Desplas, B., and Tostivint, R.: A propos de 150 cas de maladie de Dupuytren, Mém. Acad. de chir. **71**:373-379 (Oct. 17-31) 1945.

629. Einarsson, F.: On Treatment of Dupuytren's Contracture, Acta chir. Scandinav. **93**:1-22, 1946.

age was 51 years. In all, 164 hands were affected, and 84 hands were treated surgically. Excision of the palmar aponeurosis was carried out on 68 hands. The results were excellent in 43 cases (69 per cent), fair in 7 cases (11 per cent) and poor in 12 cases (20 per cent).

Whenever practicable, excision of the palmar aponeurosis is indicated. In cases of mild contracture in young persons excision of the palmar aponeurosis should be done as a prophylactic measure. In cases of mild contracture in patients over 50 years of age expectant treatment is justifiable because of the slow progress of the contracture. In cases of severe contracture in adults operation to relieve the deformity is advised.

When the general condition is good and prospects of healing are favorable, excision of the palmar aponeurosis is recommended, but in cases of severe articular contracture digital amputation may be required, the soft parts from the amputated finger being used to cover the defect in the palm left by excision of the aponeurosis. The incision should be made along the natural creases of the palm. Incision in the finger should be anterolateral.

Ayre⁶³⁰ reports on a series of 486 veterans of the guard who were examined for Dupuytren's contracture. Of these, 34 had early contracture, 25 moderately advanced contracture and 2 complete contracture. The thumb was involved in 1 case. In another there was fibrous induration of the penis. The author presents a brief review of the history, etiology, pathology and clinical features of this condition. In the present group no definite etiologic factor could be demonstrated. There was no evidence to support previous theories of causation with the exception of the theory of traumatic origin.

In civil life this condition occurs chiefly in manual workers, and it would seem that similar influences might be at work in the army after four years of daily guard duty involving the handling of a rifle for the greater part of the day.

Appraisal of Disability.—Slocum and Pratt⁶³¹ feel that the fundamental appraisal of the disability of the hand should be concerned with function. The article presented deals with the evaluation of disability of the hand and does not include the arm.

The purpose of the presentation is to introduce a simplified method of disability evaluation which incorporates the time-tested values set

630. Ayre, W. B.: Dupuytren's Contracture: Report of Sixty-Four Cases Among Veterans Guard of Canada, *J. Canad. M. Serv.* **3**:57-61 (Nov.) 1945; *Canad. M. A. J.* **54**:158-160 (Feb.) 1946.

631. Slocum, D. B., and Pratt, D. R.: Disability Evaluation for Hand, *J. Bone & Joint Surg.* **28**:491-495 (July) 1946.

forth in the past. Disability evaluation has a dual purpose: first, its traditional use in the appraisal of the end result of trauma as disease for an insurance company or an industrial accident commission; second, (and herein lies the most important purpose from a medical viewpoint) the determination of disability as a basis for planning treatment. It enables the surgeon to judge how worth while his procedure is.

The authors divide the functions of the hand into three—those of grasp, pinch and hook. The percentage values for function are 50 per cent for grasp, 30 per cent for pinch and 20 per cent for hook. The entire value of the thumb is rated as 40 per cent, because it makes up 25 per cent of grasp and 15 per cent of pinch.

A varying percentage is determined for the loss of such a portion of a metacarpal and a phalanx. There is also evaluation as to loss of sensation. It is valued at 50 per cent of the value of the hand.

Tumors.—Zuckerman and Proctor⁶³² state that a report of injuries to blood vessels in World War I reveals that aneurysms occur in 1 per cent of wounds of the extremities. A general classification of aneurysms is presented.

The traumatic arterial type of aneurysm may be subdivided into two categories, both of which are characterized by damage to the vessel wall resulting from some form of trauma. The true form is distinguished by a weakened wall which is pushed ahead and dilated, thus forming a sac.

In the false variety, or pulsating hematoma, there is a tear in the vessel wall, with ensuing hemorrhage. Varying amounts of blood take part in the formation of the hematoma, which may or may not be well demarcated from the surrounding tissue and which may burrow into the soft structures or tissue along the fascial plains. The differentiation between the true and the false aneurysm can be made from the presence or absence of muscle elements in the wall of the aneurysmal sac.

A survey of the literature reveals that Middleton reported 70 cases in 1933; in 44 the false form was present and in 16 the true form. There were 14 cases of traumatic aneurysm, but in these the condition was not a result of an open wound. The findings in cases of aneurysm are an expansive pulsating tumor, a scar from preceding injury (in the false type of aneurysm), a variable amount of pain, depending on the structures compressed by the tumor, a weak pulse distal to the aneurysm and a possible bruit over the mass.

A case of true traumatic aneurysm is presented in which treatment was surgical excision of the tumor.

632. Zuckerman, I. C., and Proctor, S. E.: Traumatic Palmar Aneurysm. *Am. J. Surg.* 72:52-56 (July) 1946.

Wildervanck⁶³³ reported on a case in which a man 30 years of age had "knuckle pads." The "pads" were at the joints of the first and second phalanges of the fingers of the right hand. They had been present for a few months. No occupational factor could be demonstrated. Some weeks before, the patient had noticed a pain in these joints on grasping an object firmly. The "pads" were apparently attached to the upper skin. Clinically, they appeared to be of a connective tissue structure and not hyperkeratotic. They were movable over the underlying tissues. Excision of a fragment confirmed the diagnosis. Histologically, there was only a thick horny layer.

In 1940 Carol described 2 cases of acanthosis and hyperkeratosis. There is no agreement as to the cause. Some writers believe that chronic trauma is a factor. Hadorn in 1944 presented a detailed account of the condition, with a bibliography. A distinction must be made between "pseudo-knuckle pads" and the extremely rare genuine type. Occasionally the pads disappear spontaneously. "Pseudo-knuckle pads" are associated with acanthosis and hyperkeratosis. In the present case no exogenous contributing factor could be demonstrated.

XIII. AMPUTATIONS, APPARATUS AND TECHNIC

Prepared by

J. WARREN WHITE, M.D., GREENVILLE, S. C.

ALTHOUGH hostilities had ceased the year before they were written, the majority of the one hundred and eighty articles on this subject could be considered as written from military experience. Over fifty foreign articles cited in the *Quarterly Cumulative Index Medicus* were unobtainable, and there was little new in the others except what will be listed in the following paragraphs.

Amputations.—Most of the articles on amputations reported series of cases interesting from one angle or another, and only three had to do with refrigeration anesthesia. Nothing particularly new has been advocated, but the use of ice rather than refrigeration machines seems to be in order, and there is emphasis on the simplicity of the ice equipment.⁶³⁴

633. Wildervanck, L. S.: Case of "Knuckle Pads," *Nederl. tijdschr. v. geneesk.* **90**:179-181 (March 2-9) 1946.

634. Miller, H. I., and Miller, P. R.: Refrigeration in Surgery, *Am. J. Surg.* **72**:694-699 (Nov.) 1946. Massie, F. M.: Refrigeration Anaesthesia for Amputation, *Tr. South. S. A.* **57**:472-482, 1945. Allen, F. M.: Amputation: Uses of Cold in Surgery, *Clinics* **4**:1642-1674 (April) 1946.

A paper has been published by Tobias⁶³⁵ discounting severely the value of refrigeration anesthesia and citing the higher mortality accompanying this type as compared with spinal anesthesia produced by cyclopropane. This is a well documented article and deserves serious consideration. He states that the advantage of the diminution of toxic agents and the reduction of the local metabolism were completely discounted by the anoxic stumps, which made an ideal field for the development of anaerobic organisms and caused a delay in wound healing. The title is misleading, however, and it is mentioned here because of the derogatory observations on refrigeration anesthesia.

Meyer⁶³⁶ has written a paper describing in detail the formation of skin flaps to avoid a secondary amputation in guillotine procedures. The article is a good one worth reading, but it is feared that the technic could not be applied in the usual case in which the guillotine amputation is indicated and that the existence of the flaps would too frequently defeat the purpose for which the amputation was originally intended.

Once more American authors (Alldredge and Thompson⁶³⁷) have written to extol the Syme amputation in an article of a military nature. There is nothing new in it, however, and it is mentioned here as an excellent defense of a procedure still generally and unjustifiably in ill repute in America.

The treatment of painful stumps and phantom limbs has been discussed in seven articles. Horrax⁶³⁸ discusses the value of cortical excisions when other methods have failed, while Pisetsky⁶³⁹ describes the use of electric shock treatment in such instances. The two papers present new methods worth considering in the extreme cases in which both surgeon and patient are at the end of their rope.

Guillaume, Bertrand, and Mazars⁶⁴⁰ again advocate the employment of myelotomy and discuss rather in detail the physiopathologic causes of painful stump.

635. Tobias, M. J.: Supracondylar Amputations (Including Evaluation of Refrigeration Anesthesia), *Ann. Surg.* **123**:473-480 (March) 1946.

636. Meyer, N. C.: Guillotine Amputation Modified to Preserve Skin Flaps, *U. S. Nav. M. Bull.* **46**:1844-1847 (Dec.) 1946.

637. Alldredge, R. H., and Thompson, T. C.: Syme Amputation, *J. Bone & Joint Surg.* **28**:415-426 (July) 1946. Alldredge, R. H.: Indication for Syme Amputations, *S. Clin. North America* **26**:422-431 (April) 1946.

638. Horrax, G.: Amputations: Experiences with Cortical Excisions for Relief of Intractable Pain in Extremities, *Surgery* **20**:593-602 (Nov.) 1946.

639. Pisetsky, J. E.: Disappearance of Painful Phantom Limbs After Electric Shock Treatment, *Am. J. Psychiat.* **102**:599-601 (March) 1946.

640. Guillaume, J.; Bertrand, I., and Mazars, G.: Case of Painful Stump Treated by Myelotomy, *Rev. neurol.* **77**:145 (May-June) 1945.

Rarely in these days is ligation of nerves recommended, but Cieslak and Stout⁶⁴¹ recommend it in addition to cutting high. They do not make injections into the nerve, however; this is another procedure which has been long discarded.

White⁶⁴² discusses in detail the mechanism of pain in neuromas and advises against the patient's waiting too long for relief because of the possibility of the developmeont of drug addiction with its distressing sequelae. Repeated resectioning of neuromas should not be done; neurectomies performed higher up as well as reamputation are useless. Except for radical leucotomy, central neurosurgical measures should be employed as a last resort only.

The early encouragement of atrophy of muscle in below-the-knee stumps by neurectomy was first advocated by Adams.⁶⁴³ This procedure may be necessary in the treatment of extremely muscular persons.

One article was written on hindquarter amputation and three on forequarter amputation. All the amputations were done for malignant tumors. Berman⁶⁴⁴ cites 2 cases in which this mutilating operation was done on the upper extremity, with only an eighteen month follow-up of the oldest patient!

The article on hindquarter amputation was written by Pack and Ehrlich,⁶⁴⁵ and it gives an excellent description of the technic employed, describing 3 new cases in which operation was performed successfully by the authors. Disarticulation of the hip joint for malignant growths was also discussed in a preceding article in this series. They state that the original 50 per cent mortality accompanying hemipelvectomy has been reduced to less than 15 per cent.

Blair and Morris⁶⁴⁶ discuss the improvement of the function of short stumps by tendon section, particularly just distal to the elbow and in below-the-knee stumps. The sectioning of the biceps brachialis adds 2 inches (5.08 cm.), while a like amount is added to the below-the-knee stump when all the hamstrings are severed. This is a well written and well illustrated article.

641. Cieslak, K., and Stout, A. P.: Traumatic and Amputation Neuromas, *Arch. Surg.* **53**:646-651 (Dec.) 1946.

642. White, J. C.: Painful Injuries of Nerves and Their Surgical Treatment, *Am. J. Surg.* **72**:468-488 (Sept.) 1946.

643. Adams, A. O.: Tibial Neurectomy to Produce Atrophy of Amputation Stumps, *J. Bone & Joint Surg.* **28**:716-720 (Oct.) 1946.

644. Berman, J. K.: Interscapulothoracic Disarticulation of Arm, *Surgery* **18**:256-266 (Aug.) 1945.

645. Pack, G. T., and Ehrlich, H. E.: Exarticulation of Lower Extremities for Malignant Tumors, *Ann. Surg.* **123**:965 (June) 1946.

646. Blair, H. C., and Morris, H. D.: Conservation of Short Amputation Stumps by Tendon Section, *J. Bone & Joint Surg.* **28**:427-433 (July) 1946.

Jones and Ryan⁶⁴⁷ have reviewed 549 amputation cases in the navy; 88 of the patients required reamputation, while 197 required revisions. They stated that 95 per cent of patients on whom guillotine amputations were done required reamputation (revision?), while only 21 per cent of those who had undergone some type of flap operation required further surgical treatment while in the authors' hands. Post-operative complications were more rare after the flap operations. Revisions and reamputations were done only when the stump was completely healed.

Jones and White⁶⁴⁸ make a valuable analysis of 829 cases; the patients were treated in naval hospitals largely under the supervision of one man. This is an excellent article which, however, has little new in it.

McKeever,⁶⁴⁹ discussing controversial points in relation to amputations, includes ten points in his summary that deserve special mention and make this article the best one of the year on amputations in general. His article deals with amputations in relation to military life, as do most other articles citing long series of cases in which amputation was performed. The various points McKeever makes are as follows:

1. The guillotine amputations are safest in the presence of sepsis.
2. Fascia and skin or skin alone should be the only covering of an amputation stump. Complete hemostasis is necessary.
3. Phantom limbs are the rule and need no treatment. Painful phantom limbs, fortunately rare, are not relieved by operation and are usually associated with drugs, alcohol or psychic factors.
4. Pedicle grafts are not satisfactory for weight-bearing stumps. Skin grafting is not necessary if traction and proper after-care are carried out.
5. End-bearing stumps are desirable in young persons. The Syme amputation gives the best possible stump.
6. Even a 1 inch stump in below-the-knee amputations is worth while.
7. Partial amputation of the foot should be done only if the anterior group of muscles can be saved.
8. A humeral stump above the insertion of the pectoralis major has no functional value. Elbows should always be saved if possible.

647. Jones, D. T., and Ryan, T. C.: *Amputee Rehabilitation: Problems of Revision and Reamputation*, U. S. Nav. M. Bull., March 1946, supp., pp. 37-64.

648. Jones, D. T., and White, W. L.: *Rehabilitation—Statistical Analysis of 829 Amputation in 769 Patients*, U. S. Nav. M. Bull., March 1946, supp., pp. 12-19.

649. McKeever, F. M.: *Discussion of Controversial Points in Amputation Surgery*, Surg., Gynec. & Obst. **82**:495-511 (May) 1946.

Long stumps with the carpal bones in are worth while, but disarticulation through the wrist is not satisfactory.

9. Cineplasty should rarely be done, if ever.

10. Physical therapy is in order for habilitation of patients with stumps. Massage per se is of little value.

In regard to articles on amputation in general, nothing really new has been proposed. There has been some discussion in various articles on improving prostheses, but aside from small mechanical details such as slight changes in the design of the knee joint and a further discussion of the merits of an inner socket, nothing original has appeared. The results of research work on this important subject being carried on are yet to be made public.

Apparatus.—There has appeared this year fewer publications to be placed under this general division.

Bunnell⁶⁵⁰ has written an article on the use of spring or elastic splints "to coax joints from the position of nonfunction into that of function and to maintain them so." To make this possible and physiologically correct, according to his teaching, Bunnell explained in detail the specifications for splints that make the surgical restoration of a hand more possible. The author claims that rigid splinting causes rigid hands and should be studiously avoided in surgical treatment of tendons and joints directed toward physiologic motion of parts rather than simple correction of deformities such as that effected by osteotomies or bone grafts. It is an article which should be kept handy for reference by surgeons employing Bunnell's methods and as a supplement to his classic book on the subject.

Along the same line, Pruce⁶⁵¹ has devised a splint to be used to prevent the development of claw hand resulting from injury. The author emphasized the fact that the splint maintains rather than corrects existing deformities. It apparently is particularly valuable as a prophylactic measure in treatment of injuries of the ulnar nerve.

Bond⁶⁵² has described another similar splint for finger traction possibly of a more active nature than that recommended in the previous two articles. He advocates the use of a trochar pointed piano wire for skeletal finger traction.

The present day dissatisfaction with conventional treatment of fractured forearms and the tendency toward mechanization are shown in

650. Bunnell, S.: Active Splinting of Hand, *J. Bone & Joint Surg.* **28**:732-736 (Oct.) 1946.

651. Pruce, A. M.: Sprint to Correct Deformity (Clawhand) Resulting from Injury, *J. Bone & Joint Surg.* **28**:397 (April) 1946.

652. Bond, B. J.: Small Type Skeletal Traction Apparatus, *U. S. Nav. M. Bull.* **46**:124-126 (Jan.) 1946.

the publication of several articles on the reduction of fractures in this area. The tendency has been encouraged by the scarcity of assistants and orderlies, which too frequently requires the surgeon to work almost by himself. Rose ⁶⁵³ has described a device for the reduction of fractures of the forearm employing traction and countertraction; the countertraction is exerted against the flexed upper part of the arm. For most of these splints the old Chinese finger trap grip, so valuable when great force is needed for a short while, is employed.

Gunther and Holzer ⁶⁵⁴ have reported another traction-countertraction apparatus similar in many ways to the one devised years ago by Souter except possibly that it has a somewhat more universal application. The article is well illustrated and calls attention to a principle that has not been sufficiently employed by the younger surgeons.

A metacarpal splint which works on the direct pressure principle rather than on the traction principle has been designed by Goldberg. ⁶⁵⁵ In his hands it apparently works well, and those wishing to try something different from the somewhat cumbersome conventional apparatus are advised to read the article.

A fourth splint has been described by Batemen, ⁶⁵⁶ but it is feared that its efficiency in a few instances has been sacrificed for universality. After reading the article, one is impressed and believes the principles to be sound although the splint must be cumbersome. The reviewer would be a little hesitant about using it.

Donehue ⁶⁵⁷ has improvised a modification of the Stokes navy stretcher for the handling of a patient with a difficult pelvic fracture when suspension is desirable. The apparatus would rarely be needed in civilian practice, but the article calls attention to another stretcher which the reviewer does not think is employed enough during these days of frequent roadside injuries and plane crashes when patients have to be carried long distances over rough terrain.

Goeringer ⁶⁵⁸ describes a "lawn chair" frame for transporting patients in plaster hip spicas. The need for rapid transportation of patients in

653. Rose, R. M.: Simple Traction Device for Reduction of Fractures of Forearm, *J. Bone & Joint Surg.* **28**:176-177 (Jan.) 1946.

654. Gunther, W. A., and Holzer, N. T.: Forearm: Apparatus for Reduction, *U. S. Nav. M. Bull.* **46**:1760-1763 (Nov.) 1946.

655. Goldberg, D.: Metacarpal Fractures: A New Instrument for Maintenance of Position After Reduction, *Am. J. Surg.* **72**:758-766 (Nov.) 1946.

656. Bateman, J. E.: Universal Splint for Deformities, *J. Bone & Joint Surg.* **28**:169-173 (Jan.) 1946.

657. Donehue, F. M.: Wounds and Injuries: Combined Stretcher and Treatment Bed for Transportation, *U. S. Nav. M. Bull.* **46**:444-446 (March) 1946.

658. Goeringer, C. F.: Aid to Handling of Patients in Hip Spica Casts, *Mil. Surgeon* **99**:130-132 (Aug.) 1946.

the army created a demand which is not encountered in civilian practice. This is a good companion article to Donehue's.

For the surgeon who has been dissatisfied with the way he has been able to apply figure-of-8 plasters in cases of injury of the clavicle, Lewin⁶⁵⁹ has reported a simple method of holding the shoulders back and yet not interfering with the application of the plaster. While the arms were held akimbo a broomstick was passed in front of the elbows and behind the back, which separated most efficiently the two ends of the clavicle while the padded plaster was being applied.

Deaver and Brown⁶⁶⁰ have written a rather complicated but detailed article on "Prescribing Crutch Gaits for Orthopedic Disabilities." These authors have made many valuable contributions to orthopedic literature, and this article is no exception. One must have read several of their previous articles to be able to follow the course of reasoning easily. An interesting point mentioned is the undesirability of using one crutch. They claim that it encourages the uneven use of the whole body. In previous articles on the use of crutches they warn continually against the use of padding on the top axillary bar of the crutch and stress the importance of having the grips properly placed for weight bearing.

After his rich experience in the European Theater during the War, Diveley⁶⁶¹ calls attention once more to the value of using the convalescent period for a reconditioning process and maintains that, after all, rehabilitation is a part of the treatment. He recommends convalescent care in civilian hospitals even in a separate wing. The responsibility of the physician in regard to the rehabilitation of the injured person is emphasized. During these days of high hospital costs and because of the scarcity of hospital beds, most of this must be done as outpatient service. It is a matter, he rightfully claims, which should be brought up continually before hospital staffs.

A simple and yet efficient foot exerciser for bed use has been reported by Schroeder⁶⁶² after several years of successful use. It is simply designed and yet provides easily regulatable resistance in the horizontal position. It is automatically pushed into the upright position and prevents foot drop and is a useful piece of apparatus to have available for patients who must spend a time in bed.

659. Lewin, P.: Simple Method by Means of Which Patient Holds His Own Shoulders Backward and Upward, *Am. J. Surg.* **71**:368-369 (March) 1946.

660. Deaver, G. G., and Brown, M. E.: Prescribing Crutch Gaits for Orthopedic Disabilities, *Arch. Phys. Med.* **26**:747-758 (Dec.) 1945.

661. Diveley, R. L.: Rehabilitation of Sick and Injured, *Occup. Med.* **2**:201-206 (Sept.) 1946.

662. Schroeder, C. F.: Therapeutic Foot Exerciser, *J. Bone & Joint Surg.* **28**:648-649 (July) 1946.

Many articles on reconditioning have appeared in the medical publications of the army and the navy in addition to Deaver and Brown's, but since little new has been recommended they will not be mentioned.

An excellent historical article on "Thomas and His Splint" was written abroad by McMurray⁶⁶³ which calls attention to the value of the splint of that name and which for all time will establish the need for this simple apparatus so universally used in fractures of the femur.

The description of another hyperextension back brace has been published by Bradford and Graham.⁶⁶⁴ Those who are able to use either the Baker or the Chambers brace would not be particularly interested in it as it differs little in construction and not at all in function from those already adequately described in the past.

Technic.—Under this title will be discussed new surgical instruments and devices for use during surgical procedures.

Verbrugge,⁶⁶⁵ of Belgium, has published a description of a bone-holding forcep which he had with him on his visit to America. A great many who saw it were favorably impressed, and it is hoped that a domestic instrument house will manufacture it. It is an improvement on the Lambotte bone holder as the handle is offset so as to be out of the way for bone plating, grafting or drilling. The article is accompanied with a plate embodying to some extent the McBride screw-staggering idea that has definite merit.

The value of Bunnell's "pull-out" wire suture for implantation and fixation of tendons was discussed favorably by Key⁶⁶⁶ in two publications. He approved of the method and considered it to be a valuable addition to surgical technic. It might be added here that it is well to adhere strictly to Bunnell's technic as the reviewer knows of several instances in which the anchorage of tendons has not held after the Bunnell technic was employed.

Current interest in spinal exploratory operations is shown by the description by Riekert and Luomanen⁶⁶⁷ of a new hemilaminectomy

663. McMurray, T. P.: *Thomas and His Splint*, Brit. M. J. **1**:872-875 (June 8) 1946.

664. Bradford, C. H., and Graham, W. C.: *Hyperextension Back Brace*, Mil. Surgeon **98**:40-42 (Jan.) 1946.

665. Verbrugge, J.: *Improved Bone Clamp and Plate for Internal Fixation of Fractures*, J. Bone & Joint Surg. **28**:174-175 (Jan.) 1946.

666. Key, J. A.: *Fixation of Tendons, Ligaments and Bone by Bunnell's Pull-Out Wire Suture*, Tr. South. S. A. (1945) **57**:187-194, 1946; *Fixation by Bunnell's Pull-Out Wire Suture*, Ann. Surg. **123**:656-663 (April) 1946.

667. Riekert, H. J., and Luomanen, R. K. J.: *Self-Retaining Hemilaminectomy Retractor*, Am. J. Surg. **71**:436-437 (March) 1946.

retractor of the self-retaining variety. The particular innovation is the use of one blade designed especially for exerting countertraction against the spinous processes. The arm of the blade is angulated at its base so as to be well out of the operative field. The reviewer has never seen this instrument but was impressed by the description and the apparent applicability.

Taylor⁶⁶⁸ has devised another spinal retractor which, it is claimed, assists the retractor holder during spinal operations. Its efficiency depends on the small projection at the deep end which is slipped under the lateral edge of the articular facet employed as a fulcrum. The reviewer has used this retractor with satisfaction and feels that no damage has been done by the rather deep penetration of the projecting end.

Another guide for nailing fractures of the femoral neck, which consists of a fork, has been described by Gaston⁶⁶⁹; when used according to the directions, one prong lies anterior to the neck and the other posterior. After roentgenologic study, the nail is driven between the prongs. This was simply a preliminary report without clinical background.

The careless manufacturing of stainless steels of various alloy content to be used in one surgical procedure has been emphasized by Key⁶⁷⁰ with justifiable indignation. The American College of Surgeons, which has in the past attempted to standardize plates and screws, should take this important problem on its program and prevent an endless amount of grief in the future. Key states with scientific accuracy: "In the light of what is known about the deleterious effect on bone of electrolysis caused by the use of metals of different composition for internal fixation, it is just as important that the metals used for internal fixation of bone be standardized as it is that drugs be of uniform purity and potency."

Eggers⁶⁷¹ reports the successful use of tantalum foil as an interposing layer in arthroplastic procedures on the jaw. No sutures are employed in this rather deep location, and it is claimed that the foil is molded by the opposing bone surfaces in use. Further reports on the use of this material in a group of cases will be looked forward to.

668. Taylor, G. M.: Simple Retractor, *J. Bone & Joint Surg.* **28**:183-184 (Jan.) 1946.

669. Gaston, F. H.: Femur-Guide for Nailing Fractures of Neck, *South. M. J.* **39**:690-692 (Sept.) 1946.

670. Key, J. A.: Electrolytic Absorption of Bone Due to Use of Stainless Steels of Different Composition for Internal Fixation, *Surg., Gynec. & Obst.* **82**:319-322 (March) 1946.

671. Eggers, G. W. N.: Arthroplasty of Temporomandibular Joint in Chicken with Interposition of Tantalum Foil: Preliminary Report, *J. Bone & Joint Surg.* **28**:603-606 (July) 1946.

Eggers⁶⁷² has described a bone plate slotted to allow continuous bone contact as absorption of fracture ends occurs. This follows up the idea of Gilfillin in possibly a more efficient way.

Lambert and Horwitz⁶⁷³ have described three instruments which they claim facilitate the performance of the Bankhart operation for recurrent dislocation of the shoulder. One is a forked "pusher" to get the humeral head out of the way and permit the visualization of the lesion on the anterior glenoid lip, another is a right angle drill for properly placing the sutures in the damaged capsule and the third is a specially devised right angle suture carrier. They state that they have been considerably aided in the performance of their last eight Bankhart operations for recurrent dislocation of the shoulder.

Immediate surgical treatment of vessels is discussed by Mustard,⁶⁷⁴ who has employed glass tubes of proper caliber at the preliminary operation, to be replaced within six days by venous grafting. He states that one of the main difficulties is the heparinization of the patient through proper laboratory cooperation. He is not too optimistic about the results from this heroic type of surgical intervention but feels that it is a beginning in a new field.

Mayer,⁶⁷⁵ of New York, has published reports on operations on vertebral bodies—another heroic procedure. He discusses 6 cases, in 2 of which the lumbar bodies were approached between the erector spinae group and the quadratus lumborum. Drainage for pyogenic infection was performed successfully in 2 cases. Fatal termination occurred in 2 cases after exploration of neoplastic (malignant) processes, and in another there was recovery from an aneurysmal bone cyst of the seventh dorsal body.

The ability of tissue to tolerate nylon both for buried and cutaneous sutures, is reported on favorably by Rowe,⁶⁷⁶ particularly when bone is involved and when other forms of suture are contraindicated. Its use in repair of acromioclavicular separations, metatarsus primus varus and fractured patellae is reported. One difficulty which the reviewer has had with nylon sutures is his inability to tie a knot which continues tight.

672. Eggers, G. W. N.: Contact Splint, *Texas Rep. Biol. & Med.* **4**:42-45, 1946.

673. Lambert, R. G., and Horwitz, T.: Three Instruments Designed to Facilitate Bankhart Operation for Recurrent Dislocation, *J. Bone & Joint Surg.* **28**: 641-643 (July) 1946.

674. Mustard, W. T.: Arterial Wounds: Technic of Immediate Restoration of Vascular Continuity; Indications and Results, *Ann. Surg.* **124**:46-59 (July) 1946.

675. Mayer, L.: Operations on Bodies of Vertebrae, *J. Internat. Coll. Surgeons* **9**:104-111 (Jan.-Feb.) 1946.

676. Rowe, M. J.: Nylon Suture, *Surgery* **18**:764-768 (Dec.) 1945.

To assist in early closure of extensively débrided wounds, Gay⁶⁷⁷ has advocated the extensive use of split skin grafts between the fifth and tenth day after injury. He is of the opinion that the thinner the graft is the more it is liable to survive. This is another article written from experiences in military service.

Eggers and Rowland⁶⁷⁸ have called attention to the ease with which the proximal one third of the humerus is exposed through a postero-lateral curved incision from the tip of the shoulder to the deltoid tuberosity. It occurs to the reviewer also that this may be desirable for cosmetic reasons.

Lattes and Frantz⁶⁷⁹ noted that the presence of oxidized cellular sponges seemed to interfere considerably with the repair of bone. No clinical experience otherwise was cited, but its use as an interposing membrane in such procedures seems appropriate. The idea may be a good one, but one is a little afraid that tissue might be intolerant to the amount which would be effective.

A subject which deserves further elaboration has been discussed by Klinefelter,⁶⁸⁰ i. e., the malinterpretation of roentgenograms. Unnecessary operations might be performed or necessary operations might not be performed if roentgenograms are misinterpreted, and the author justifiably calls attention to the necessity of knowing just how each exposure is made. This brief article opens up a field for discussion of great practical value. It is hoped that the subject will be gone into more extensively by those who are capable of correctly interpreting roentgenograms and have a practical clinical insight.

Several authors have discussed the use of ice as a therapeutic or postoperative aid other than an anesthetic for amputations. Schaubel⁶⁸¹ emphasizes its use as a postoperative aid in containers about casts, stating that the need for splitting casts was reduced from 42 to 5 per cent by the generous use of ice bags.

Massie⁶⁸² once more advocates the use of ice in keeping an extremity anesthetized and properly preserved pending the conditioning of

677. Gay, E. C.: Skin Dressings (Splint Grafts) in Treatment of Debrided Wounds, *Am. J. Surg.* **72**:212-218 (Aug.) 1946.

678. Eggers, G. W. N., and Rowland, R. H., Jr.: Incision for Exposure of Proximal One Third of the Humerus, *M. Rec. & Ann.* **40**:1551-1558 (Sept.) 1946.

679. Lattes, R., and Frantz, V. K.: Absorbable Gauze in Bone Surgery, *Ann. Surg.* **124**:28-39 (July) 1946.

680. Klinefelter, E. W.: Influence of Position on Measurement of Projected Bone Angle, *Am. J. Roentgenol.* **55**:722-725 (June) 1946.

681. Schaubel, H. J.: Local Use of Ice After Orthopedic Procedures, *Am. J. Surg.* **72**:711-714 (Nov.) 1946.

682. Massie, F. M.: Refrigeration Anaesthesia, *Ann. Surg.* **123**:937-947 (May) 1946.

a patient for necessary surgical treatment, particularly, of course, after severe trauma. There is nothing new in this article, but it is hoped that throughout the country emergency rooms in large hospitals will become more familiar with this valuable lifesaving procedure in treatment of severely injured patients.

Increased interest in anesthesia produced by cold is shown by two articles that appeared in journals devoted to anesthesiology.⁶⁸³ It is the reviewer's opinion that anesthesiologists were unjustifiably discounting the value of this method of reducing pain and producing surgical anesthesia.

683. Kanaar, A. G.: Refrigeration in Treatment of Trauma, with Review of Crymotherapy, *Anesth. & Analg.* **25**:177 (Sept.-Oct.); 228 (Nov.-Dec.) 1946. Lobachev, S. V.: Refrigeration Anaesthesia in Surgery of Extremities, *ibid.* **25**: 22-30 (Jan.-Feb.) 1946.

HIATUS HERNIA

G. G. RICHARDS, M.D.

AND

K. A. CROCKETT, M.D.

SALT LAKE CITY

HIATUS hernia is a far more frequent condition than has been generally accepted. It is not a rare thing. It is often overlooked, and the patients are treated for peptic ulcers, disease of the gallbladder or coronary heart disease. Of course, the same patient may have any of these conditions along with a hiatus hernia.

The allotted time will not permit a complete discussion of this subject, so we are confining it to a review of 24 cases which we have encountered in the last eighteen months at the Salt Lake Clinic. Incidentally, this is a larger number than was found in the previous thirty years. Our experience is probably not unique but goes to prove that once physicians are alerted to the existence of this type of hernia, it will be found much more frequently.

A thorough history will indicate definite symptoms suggestive of a hiatus hernia to the physician who is conscious of the existence of this condition. It occurs most frequently after 50 years of age, and reports have shown it to be more frequent in females than in males.

The commonest symptom is pain, usually under the lower half of the sternum or in the epigastrium. It may be referred to the back or up into the left shoulder and arm. It may be excruciating or described as a lump under the lower part of the sternum, pressure or a burning sensation. It occurs most frequently after heavy meals, especially if followed by stooping, lifting, lying down or rising up in bed or by anything that increases intra-abdominal pressure. The duration of the pain will depend on whether it is a sliding type of hernia or a fixed one or if it is complicated by an ulcer in the pouch, in which case it will be similar to the characteristic pain of any peptic ulcer.

Relief of pain on assumption of the upright position is characteristic of the sliding type of hernia. Dysphagia may be the first symptom experienced by the patient. Hot or cold foods or liquids, as well as roughage, may cause painful swallowing.

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Symptoms referable to the heart are common and lead to the diagnosis of heart disease. Hemorrhage occurs in hernias complicated by peptic ulcer in the pouch or from an associated ulcer in the stomach or duodenum. Symptoms referable to the other conditions occasionally associated with hiatus hernia may overshadow those referable to the hernia itself. The hernia is frequently overlooked until the symptoms of the associated condition are removed, as in excision of a gallbladder with stones, and one has to continue the search for a cause of the persisting pain.

A correct diagnosis can be made only by a roentgenologic examination. Some roentgenologists prefer the supine position at the time barium is swallowed, with rotation of the patient from side to side. We have been more successful when the Trendelenburg position has



Fig. 1.—Hiatus hernia in case 1 (A) and case 2 (B).

been used. Generally the hernia is overlooked if the entire examination is made in the upright position, even though the patient be later examined in the supine position.

The following is a review of a few of our cases, with further emphasis on some of the characteristic symptoms and signs of hiatus hernia.

CASE 1.—Mr. S. L. H., a farmer aged 40, complained of epigastric pain for one month. The patient was cranking a tractor and strained himself and had sudden gnawing epigastric pain. He was taken to a hospital for observation. Two conventional series of gastrointestinal roentgenograms were normal. He was released after several days, on a liquid diet. He continued to have intermittent pain.

Physical examination showed the patient to be stocky, with a weight of 177 pounds (80.3 Kg.). The blood pressure was 130 systolic and 70 diastolic. The roentgenogram of the gallbladder was normal, and one of the upper part of the gastrointestinal tract showed hiatus hernia (fig. 1).

Treatment.—He was placed on a reduction diet.

CASE 2.—Mr. L. L. W., an automobile mechanic aged 47, complained of burning pain near the right sternal border produced by pulling on a wrench when he was in a cramped position, present for two years. The pain occurred at times when he lay down. This man had been under treatment for coronary insufficiency for two years without relief of symptoms.

The patient was obese, with a weight of 182½ pounds (83 Kg.). The blood pressure was 146 systolic and 88 diastolic. He was otherwise normal. The electrocardiogram was normal, as were the stomach and duodenum. A roentgenogram of the upper part of the gastrointestinal tract revealed hiatus hernia (fig. 1 B).

Treatment.—He was placed on a reduction diet.

CASE 3.—Mr. F. C. B., aged 39, was a postmaster. His chief complaint was substernal pain, brought on while swallowing food and relieved by waiting or

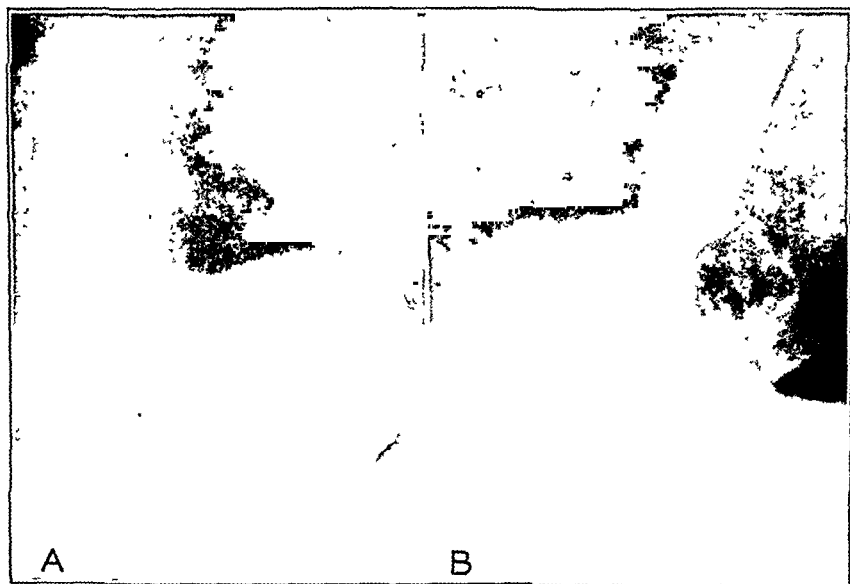


Fig. 2.—A, hiatus hernia in case 3; B, hiatus hernia partially filled with gas bubble in case 4.

by swallowing water. He also complained of heartburn, made worse by belching. He was rejected for military service on the basis of gastric neurosis. A conventional series of gastrointestinal roentgenograms at that time was reported to be normal. The patient was stocky, weighing 185 pounds (83 Kg.). The blood pressure was 120 systolic and 72 diastolic. There was a small indirect inguinal hernia on the left. Gastric analysis showed free hydrochloric acid amounting to 103 and total hydrochloric acid 114. The roentgenogram of the gallbladder was normal. A roentgenogram of the upper part of the gastrointestinal tract revealed hiatus hernia (fig. 2 A). The stomach and duodenum were normal.

Treatment.—The patient was placed on small bland feedings with antacids and advised to reduce his weight.

CASE 4.—Mr. W. M. W., aged 54, weighed 170 pounds (77 Kg.). On Feb. 7, 1942, he was awakened about 3 a. m. with excruciating pain in the epigastrium about eight hours after eating popcorn. At 6 a. m. he was seen by a

physician, who suspected a coronary occlusion. Intravenous administration of aminophylline gave no relief. Morphine, 0.5 grain (0.03 Gm.), was required for relief. The pain returned in six hours, again requiring morphine. Physical examination was noncontributory. An electrocardiogram and a roentgenogram of the gastrointestinal tract, made in the upright position, were normal. The genitourinary tract and the gallbladder were normal on roentgenograms, except that the gallbladder was slow in emptying.

The patient had no recurrence of pain until January 1948. After eating breakfast he stooped over from a standing position to tie his shoe and experienced a severe pain in the epigastrium and shortness of breath. Both subsided after he got into his car. One hour later, while walking briskly in the cold air, he was

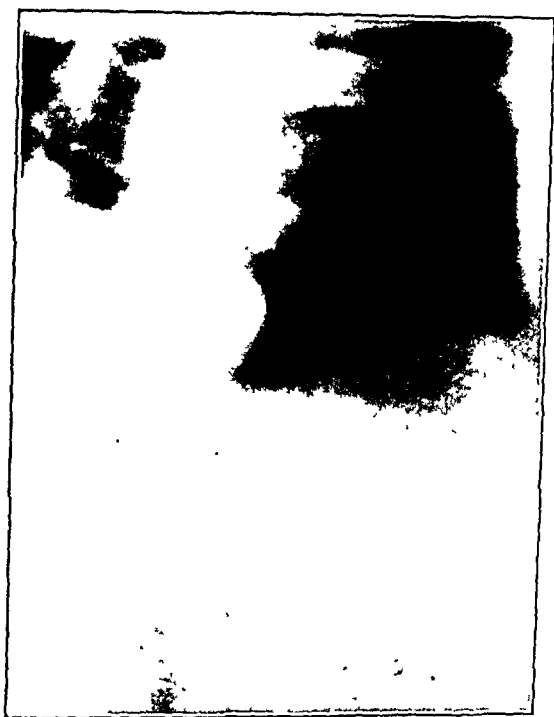


Fig. 3.—Hiatus hernia in case 5.

seized with a pain in his chest and left arm. The pain subsided after he sat down. He continued to have the same pain each time he climbed stairs or walked in the open. The company physician took an electrocardiogram and a roentgenogram of his chest, which were normal.

Physical examination was essentially noncontributory. Laboratory examination revealed nothing abnormal except for a hemoglobin content of 17.15 Gm. and 5,790,000 red blood cells. An electrocardiogram showed posterior myocardial infarction. A roentgenogram of the gastrointestinal tract in the Trendelenburg position revealed a sliding type of hiatus hernia (fig. 2 B).

Treatment.—The patient was treated for the myocardial infarction and for overweight, with satisfactory results to date.

CASE 5.—Mr. J. L. Y., aged 47, was a manufacturer. On Oct. 20, 1947, his chief complaint was pain beneath the xiphoid for three months. The onset

of epigastric pain had occurred three months previously, and it had lasted almost steadily for two days, with no associated symptoms. Since the onset the pain had returned with exertion and when the patient lay flat in bed. It was relieved by rest. The patient was obese, with a weight of 218 pounds (99 Kg.). The blood pressure was 120 systolic and 78 diastolic. Otherwise the condition was normal on physical examination. The roentgenogram of the gallbladder was normal. A roentgenogram of the upper part of the gastrointestinal tract revealed a hiatus hernia (fig. 3). The electrocardiogram was normal (fig. 4 *A*). The problem was to differentiate epigastric pain caused by a hiatus hernia in an obese man from that of coronary insufficiency.

An exercise test was done, which resulted in an abnormal electrocardiogram and brought on epigastric pain which was not relieved by oxygen and vasodilators (fig. 4 *B*). Later cardiograms were typical of anteroseptal infarct. The patient was hospitalized and treated for a myocardial infarction and given a reduction diet. Recurrence of epigastric pain was frequent unless he slept in a semireclining posture.

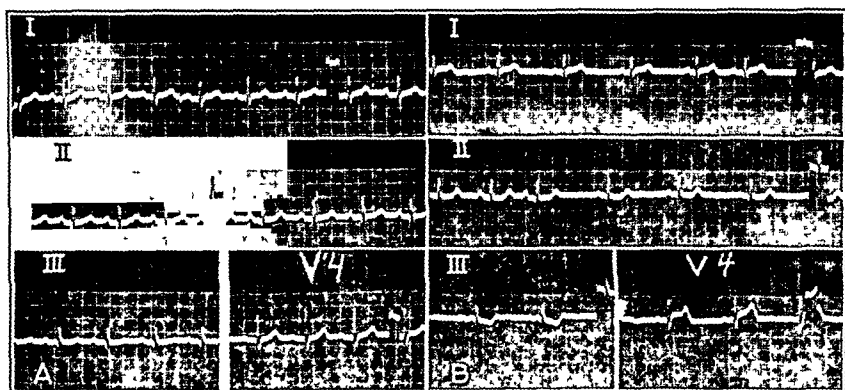


Fig. 4 (case 5).—*A*, electrocardiogram before exercise; *B*, electrocardiogram after exercise, showing definite evidence of coronary insufficiency.

He was last seen on May 20, 1948, had lost 27 pounds (12 Kg.) and was entirely free of pain.

CASE 6.—Mrs. H. L. B., a housewife aged 68, weight 158 pounds (71.7 Kg.), underwent partial thyroidectomy for toxic goiter in 1928. She gained 20 pounds (9 Kg.) in the next two years and required thyroid extract for hypothyroidism.

In 1931 she was subjected to dilation and curettement and received radium for fibroid uterus. In 1932 she began to have pain in the lower part of the chest and epigastric pain, referred to both arms, which was relieved by nitroglycerin. This pain was associated with exertion. She continued to take nitroglycerin several times a day with relief as a rule, up to 1937, when she realized she had another type of pain, thought to be due to gallstones. The pain was severe in the lower right region of the chest and the epigastrium. It occurred during sleep or when the patient was getting up, lasting several hours. A roentgenogram of the gallbladder was normal. She had similar attacks of pain for ten years.

On Feb. 7, 1947, a roentgenogram of the gallbladder was normal. A roentgenogram of the gastrointestinal tract in the Trendelenburg position revealed a hiatus

hernia (fig. 5 *A*). The stomach and duodenum were normal. There was diverticulosis of the colon.

This patient undoubtedly had both a hiatus hernia and angina pectoris although numerous cardiograms taken over the last fourteen years have all been entirely normal.

She was placed on a reduction diet and advised to avoid exertion, especially after meals.

CASE 7.—Mr. E. E. W., a salesman aged 53, on Sept. 19, 1947, presented the chief complaint of pain in the chest for nine years. He was kicked in the abdomen in 1920 and had vague epigastric pain intermittently until 1939, when he had severe epigastric and substernal pain which was diagnosed "myocardial infarction." He was hospitalized for three months and then stayed in bed nine more months. The pain continued intermittently while the patient was at bed rest and afterward. He was incapacitated because of "anginal syndrome."

The weight was 160 pounds (72.6 Kg.). The blood pressure was 136 systolic and 84 diastolic. He was of stocky build. Physical examination revealed a normal condition.

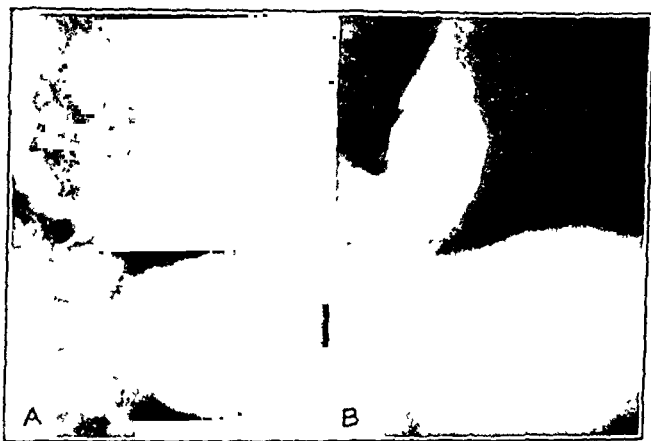


Fig. 5.—*A*, hiatus hernia in case 6; *B*, hiatus hernia for which the left phrenic nerve was crushed in case 7.

The roentgenogram of the chest was normal, as was the electrocardiogram after the exercise of stair climbing. The anoxia test showed vasomotor collapse at nine minutes but no electrocardiographic changes. A roentgenogram showed hiatus hernia (fig. 5 *B*).

Treatment.—A reduction diet of bland foods and administration of antispasmodics and alkalis gave no results. The patient asked for surgical treatment. Block of the phrenic nerve (left) with procaine hydrochloride relieved the pain; hence, the phrenic nerve was crushed, which gave complete relief, according to the patient when he was last seen.

CASE 8.—Mrs. S. B. S., aged 52, weight 167 pounds (75.7 Kg.), on Jan. 27, 1948, presented the chief complaint of (1) pain in the lower part of the chest and the epigastrium for two months, made worse by turning over or rising up in bed and especially severe when she got up in the bathtub; (2) pain in the right arm and the side of neck, made worse by any motion of the head or arm and with no relation to epigastric pain, and (3) palpitation and dyspnea on exertion.

The physical examination revealed nothing abnormal except for a painful right arm and shoulder and tenderness of the brachial plexus. There was some limitation of motion of the neck. There was no scalenus anticus syndrome. A roentgenogram revealed arthritis of the cervical region of the spine and a hiatus hernia (fig. 6). The patient was put on a reduction diet, with small meals.

By Feb. 18, 1948, she had lost 14 pounds (6.4 Kg.) but the pain in the epigastrium had been constant. Procaine hydrochloride was injected into the left phrenic nerve, with complete relief of pain, and then the nerve was crushed.

She was seen at the clinic for follow-up on May 27, 1948, and had lost 13 pounds (6.4 Kg.) more and was entirely free of pain in spite of the fact that the diaphragm on the left side was again beginning to move with respiration.



Fig. 6 (case 8).—Hiatus hernia for which the left phrenic nerve was crushed.

SUMMARY

Twenty-four cases of hiatus hernia were observed at the Salt Lake Clinic in the last eighteen months. This was more than were found in the previous thirty years.

Age.—The age varied between 33 and 68 years. Three patients were under 45 years of age.

Sex.—Seventeen patients were men, and 7 were women.

Weight.—Sixteen of the 24 patients were overweight.

Symptoms.—Twenty-three patients complained of either epigastric or substernal pain; 7 of these had radiation of the pain into the left

shoulder or arm. Only 1 had dysphagia. Two patients had gastrointestinal hemorrhages with anemia. The duration of symptoms was from six months to twenty years. The average duration was five and one-third years.

Form of Previous Therapy.—Seven patients had been treated for coronary heart disease, 5 had been treated for disease of the gallbladder, 7 had been treated for peptic ulcer and 7 had received no definite form of treatment. (Four patients had received treatment for both disease of the gallbladder and peptic ulcer or disease of the gallbladder and coronary heart disease.)

CONCLUSIONS

In conclusion, we wish to point out that whereas the frequency of hiatus hernia in recent medical literature varies from 0.6 per cent to as high as over 12 per cent in routine roentgenologic studies of the gastrointestinal tract it must be looked for by special technic if it is to be found more than occasionally. Hiatus hernia must be kept in mind in any case of atypical angina pectoris, duodenal ulcer, dysphagia, disease of the gallbladder, anemia from gastrointestinal bleeding or obscure upper abdominal pain or pain in the lower part of the chest which might be associated with increased intra-abdominal pressure. The index of suspicion has to be accompanied with a special technic of fluoroscopy if the true incidence of this disorder is ever to be appreciated.

INCIDENCE OF HIATUS HERNIA AND ASSOCIATED LESIONS DIAGNOSED BY ROENTGEN RAY

IRVING B. BRICK, M.D.

Instructor of Medicine, Georgetown University School of Medicine, and Chief of the Gastroenterology Clinic, Outpatient Department, Georgetown University Hospital

WASHINGTON, D. C.

THE TRANSITION of hernia of the esophageal hiatus, more commonly called hiatus hernia, from a rare entity to one of comparative frequency has taken place in the past two decades. It was some years after the advent of diagnostic roentgenology that appreciation of the diagnostic value of changes in position of patients during barium study of the gastrointestinal tract led to routine study of the patient in the prone, supine or Trendelenburg positions. Ritvo¹ in 1930 emphasized the importance of this maneuver in bringing to light many previously undiagnosed hiatal hernias, particularly of the recurrent, small variety which may be seen only in the Trendelenburg position and may, indeed, be absent at another examination. Jenkinson and Roberts² estimated that only 5 per cent of hiatus hernias could be diagnosed if the erect position alone were used during examination.

Since the radiologist has attained a high degree of awareness of this entity, with proficiency in diagnosis, an evaluation of the frequency of hiatus hernia, diagnosed by the roentgen ray, was undertaken. The clinical significance of the presence of a hiatus hernia in a patient is largely determined by the clinician. Since the clinical manifestations presented by the patient with a hiatus hernia notoriously simulate those of other common entities diagnosed by the roentgen ray, it was thought to be of some value to determine the type and frequency of accompanying lesions in such patients. It was believed that such a study might add to clarification of the clinical status of the patient with a hiatus hernia.

Read before the Section on Gastro-Enterology and Proctology at the Ninety-Seventh Annual Session of the American Medical Association, Chicago, June 23, 1948.

From the Fifth and Sixth Medical Services (Boston University) and the Radiology Department, Boston City Hospital, Boston, and the Department of Medicine, Georgetown University School of Medicine, Washington, D. C.

1. Ritvo, M.: *Hernia of the Stomach Through the Esophageal Orifice of the Diaphragm*, J. A. M. A. **94**:15 (Jan. 4) 1930.

2. Jenkinson, E. L., and Roberts, E. W.: *Lesions of the Diaphragm*, Am. J. Roentgenol. **38**:584 (Oct.) 1937.

MATERIAL AND METHODS

The reports of all barium studies of the upper gastrointestinal tract done in the Radiology Department in two years, 1945 and 1946, at the Boston City Hospital were analyzed. Patients were referred from the various medical, surgical, specialty and outpatient services of a large general hospital mainly by house officers at the intern and resident level. In many cases gastrointestinal complaints were present, but in others it is likely that the roentgenologic study was part of a diagnostic work-up. Routinely, in this roentgen ray department study of the patient lying down or in the Trendelenburg position is done.* No differentiation was made in the types of esophageal hernia since the clinical manifestations do not differ in the various types.

Table 1 reveals that among 3,448 patients examined in the two year period there were found 308 hernias of the esophageal hiatus, an incidence of 8.93 per cent. This was the second most frequent lesion

TABLE 1.—Incidence of Most Frequent Diagnosis in Roentgen Examinations of the Upper Gastrointestinal Tract

	No. of Patients	Duodenal Ulcer		Hiatus Hernia		Gastric Ulcer		Carcinoma of Stomach	
		No. of Cases	%	No. of Cases	%	No. of Cases	%	No. of Cases	%
1945	1,619	315	19.45	140	8.64	50	3.03	41	2.53
1946	1,829	390	21.32	168	9.18	70	3.82	60	3.28
Totals.....	3,448	705	20.41	308	8.93	120	3.46	101	2.92

diagnosed, duodenal ulcer having been found in 20.41 per cent of patients. It was more than twice as frequent as gastric ulcer or gastric carcinoma.

Examination of table 1 shows a good degree of consistency in the frequency of diagnosis of the lesions listed in both years. While the frequency of diagnosis in this series is higher than in most previously reported, some authors have also found a similar incidence. Schnepf³ collected from the literature a thorough tabulation of the frequency of this lesion, finding an incidence varying from 0.02 to 8.0 per cent, which reflects its comparatively recent widespread recognition.

Harrington,⁴ at the Mayo Clinic, estimated that its diagnosis was twenty times commoner in the past decade than in the previous two decades. Kirklin and Hodgson⁵ recently reported 306 cases of esopha-

3. Schnepf, K. H.: Diaphragmatic Hernia: Its Incidence and Treatment, Illinois M. J. **83**:404 (June) 1943.

4. Harrington, S. W.: Diagnosis and Treatment of Various Types of Diaphragmatic Hernia, Am. J. Surg. **50**:381 (Nov.) 1940.

5. Kirklin, B. R., and Hodgson, J. R.: Roentgenologic Characteristics of Diaphragmatic Hernia, Am. J. Roentgenol. **58**:77 (July) 1947.

geal hiatus hernia diagnosed by roentgen ray in a one year period. Nuzum⁶ reported an incidence of 12.27 per cent in 957 patients who had roentgenologic study in which a search for hiatus hernia was a routine part of the procedure.

Interesting, also, is Harrington's observation⁴ on examination of the esophageal hiatus routinely in the course of 1,000 consecutive abdominal operations. He found that in 55 per cent of the cases the hiatus closely approximated the lower end of the esophagus. In 35 per cent one finger could be inserted between the esophagus and the margins of the esophageal hiatus; in 8 per cent two fingers could be inserted and in 2 per cent two to three fingers. In these last two groups herniation was thought to be potentially possible. These findings suggest an anatomic counterpart of closely comparative frequency to the incidence diagnosed by roentgen ray in this study.

Table 2 shows the incidence of the 308 hiatus hernias by sex and age. As in other series, women predominate, but by a much smaller margin than is usually given. For instance, Kirklin and Hodgson⁵

TABLE 2.—Incidence of 308 Hiatus Hernias by Sex and Age

Age	Women	Men	Totals	% by Decade
20 to 30.....	1	2	3	0.97
30 to 40.....	6	11	17	5.51
40 to 50.....	21	16	37	12.01
50 to 60.....	46	43	89	28.89
60 to 70.....	41	35	76	24.67
70 to 80.....	41	30	71	23.05
80 to 90.....	9	5	14	4.54
Over 90.....	..	1	1	0.32
	165	143	308	

reported the occurrence of hiatus hernias to be twice as frequent in women. Only 20 of the patients who had hiatus hernias were below 40 years of age. As in other series, the majority of patients are in the sixth to eighth decades of life. In the present study, such age groups accounted for 76.61 per cent of the cases. That the occurrence in the older age groups is not accounted for on the basis of the presence of a disproportion of elderly persons in this series is attested to by the frequency of diagnosis in this study of duodenal ulcer, a disease not restricted to the elderly.

The uniformity of age undoubtedly is of etiologic importance. Degenerative changes resulting in a loss of elasticity of the hiatal tissues contribute to the formation of the hernia. Abnormal stress, such as would occur in frequent episodes of coughing, retching or vomiting, could also stretch and possibly tear the tissues of the hiatal orifice. Increased intra-abdominal pressure from any cause is also

6. Nuzum, F. R.: Hernia of Esophageal Hiatus: Its Relationship to Angina Pectoris, *Am. Heart J.* **33**:724 (May) 1947.

a frequent factor in inducing changes at the esophageal hiatus. Obesity, large abdominal tumors or ascites may be contributing factors in this regard. Childbearing has a definite relationship to the development of hiatus hernia. Among 195 women in the third trimester of pregnancy, Rigler and Eneboe⁷ found hiatal hernias in 18 per cent of 116 multiparas and 5 per cent of 79 primiparas. In only 3 of 10 women examined one to eighteen months post partum was the hernia again found. Schnepf⁸ and Evans and Bouslog⁹ have found hiatus hernia to explain some cases of "intractable heartburn" of pregnancy.

Many authors have proposed that hiatus hernia is primarily a congenital defect. In cases in which it occurs in infancy and usually involves the appearance of a greater part of the stomach, usually with other viscera, in the thoracic cavity, it is a congenital lesion. This is probably true also when it appears in adults in whom there is a short esophagus, with over a third of the stomach intrathoracically situated. Kirklin and Hodgson⁵ stated that congenitally short esophagus with thoracic stomach is a rare lesion. It is really not a hiatus hernia since, with a congenitally short esophagus, the stomach has not herniated through the esophageal hiatus because it never was below the diaphragm at any time. From a roentgenologic point of view, they point out that three types of hiatus hernia may be differentiated. The commonest type, occurring in 66.5 per cent of their group, is the esophageal hiatal hernia in which the esophagogastric junction is above the diaphragm and both the stomach and the lower end of the esophagus are contained in the hernia. The next type is that in which there is a shortened esophagus, which occurred in 26 per cent of their cases, and it implies that at one time the esophagus was longer but that it has now become shortened. The third type, which occurred in 7.5 per cent of the cases, is the paraesophageal hernia in which a portion of the stomach herniates through the esophageal hiatus but the esophagogastric junction remains below the diaphragm and no esophagus is present in the hernia. In the present study, no differentiation is made between types since the clinical manifestations of all types are similar and do not lend themselves to differentiation. In the majority of cases, it seems rather unlikely for a congenital lesion to appear so frequently at the advanced ages at which hiatus hernia is found.

In this study 223 lesions were described by the radiologist as small, 68 as moderate and only 17 as large (over a third of the stomach in

7. Rigler, L. G., and Eneboe, J. B.: The Incidence of Hiatus Hernia in Pregnant Women and Its Significance, *J. Thoracic Surg.* 4:262 (Feb.) 1935.

8. Schnepf, K. H.: Diaphragmatic Hernia as a Cause of "Intractable Heartburn" of Pregnancy, *Am. J. Obst. & Gynec.* 46:142 (July) 1943.

9. Evans, J. R., and Bouslog, J. S.: Intractable Heartburn of Pregnancy, *Radiology* 34:530 (May) 1940.

the thorax). Thirty-nine of the 308 lesions were described as being of the shortened esophagus type.

ASSOCIATED GASTROINTESTINAL LESIONS

Table 3 presents a study of the frequency and nature of associated conditions diagnosed concurrently with hiatus hernia. The associated diagnoses are not included in table 1 in the calculation of the incidence of duodenal ulcer, gastric ulcer or carcinoma. Thus, 25 per cent of this group of hiatus hernias are accompanied with conditions which in themselves may be responsible for, or potentially causative factors of, the clinical picture. The occurrence of 31 duodenal ulcers is an incidence rate of 10 per cent in the cases of hiatus hernia, as contrasted to 20.41 per cent in the whole group. There is obviously no etiologic significance.

TABLE 3.—*Associated Gastrointestinal Lesions Diagnosed by Roentgen Ray Study in 308 Cases of Hiatus Hernia*

	No. of Cases
Esophageal diverticulum	5
Esophageal varices	3
Esophagitis	3
Esophageal carcinoma	1
Gastric ulcer	2
Gastric carcinoma	4 (2) *
Gastric diverticulum	1
Gastritis, hypertrophic	7
Hypertrophy of pylorus.....	1
Duodenitis	3
Duodenal ulcer	31
Duodenal diverticulum	15
Jejunal diverticulum	3
Total	79

* Clinical investigation of these 4 cases revealed that in only 2 was carcinoma actually present. In the other 2 cases (1 at operation and 1 at necropsy) carcinoma of the stomach was not present.

Additionally, there were 5 cases in which an ulcer niche or crater was noted within the herniated portion. Huber and Andreson¹⁰ in 1942 were able to collect from the literature 33 cases of ulcer in situ and added 4 new ones. There have been several single case reports since that time.

Though there were no esophageal ulcers noted in this series, it is of interest that Dick and Hurst¹¹ were of the opinion that chronic esophageal ulcer rarely occurs without the presence of a hiatus hernia

10. Huber, F., and Andreson, L. H.: Gastric and Duodenal Ulcer Associated with Lesions of the Lower End of the Esophagus and the Cardia of the Stomach, *Am. J. Roentgenol.* **48**:158 (Aug.) 1942.

11. Dick, R. C. S., and Hurst, A.: Chronic Peptic Ulcer of the Esophagus and Its Association with Congenitally Short Esophagus and Diaphragmatic Hernia, *Quart. J. Med.* **11**:105 (April) 1942.

of the congenitally short esophagus type. Particularly with the short esophagus type, there is loss of the normal valvular mechanism at the cardia, which allows regurgitation of stomach contents into the esophagus, especially when the patient is lying down. The acid stomach content thus aids in formation of the esophageal ulcer.

Johnstone,¹² on the other hand also, felt that a hiatus hernia was invariably present, being found in 20 of his 21 cases of esophageal ulcer. However, he strongly dissented to the proposed idea that the shortened esophagus was of a congenital nature. Rather, the esophagus may become shortened because of fibrosis and healing of the ulcer; in other words, there is an acquired shortening of the esophagus. This better explains the old age of the groups involved than the postulation of a basic congenital lesion. Dick and Hurst objected to this on the basis that if sufficient cicatrization occurs to shorten the esophagus and pull the stomach into the thorax it might be expected to cause esophageal stenosis, which apparently had not occurred in their experience. Interesting on this point is Benedict's thorough study¹³ of 44 cases of benign esophageal nontraumatic stricture, in which series a hiatus hernia was present in 17, or 38 per cent. Thus, hiatus hernia is seen to be an important factor in benign esophageal stenosis.

Wilkinson¹⁴ reported 6 duodenal ulcers in 70 cases of hiatus hernia, while Polley¹⁵ found 4 duodenal ulcers in 47 cases. Jankelson and Morein¹⁶ stated that ulcer of the stomach and duodenum accompanied hiatus hernia in 25 per cent of the cases. The findings in the present series are fairly consistent with the other reports.

Weintraub and Tuggle¹⁷ found that in 310 cases of diverticulum of the duodenum 9 per cent of the patients had an associated hiatus hernia. Conversely, Polley¹⁵ found that in 10 per cent of 47 cases of hiatus hernia a duodenal diverticulum was present. This compares with an incidence of 5 per cent in this series. Diverticulosis of the colon occurred in 34 per cent of Polley's cases and in 23 per cent of Wilkinson's¹⁴ 70 cases of hiatus hernia.

12. Johnstone, A. S.: Peptic Ulceration of the Esophagus with Partial Thoracic Stomach, *Brit. J. Radiol.* **16**:357 (Dec.) 1943.

13. Benedict, E. B.: Benign Stricture of Esophagus, *Gastroenterology* **6**:328 (April) 1946.

14. Wilkinson, S. A.: Diaphragmatic Hernia, *New England J. Med.* **210**:1105 (May 24) 1934.

15. Polley, R. F.: Congenital Short Esophagus with Thoracic Stomach and Esophageal Hiatus Hernias, *J. A. M. A.* **116**:821 (March 1) 1941.

16. Jankelson, I. R., and Morein, S.: Complications of Diaphragmatic Hernia, *Rev. Gastroenterol.* **7**:134 (March-April) 1940.

17. Weintraub, S., and Tuggle, A.: Duodenal Diverticula, *Radiology* **36**:297 (March) 1941.

While not studied in the present series, it is interesting to note that either roentgenologic or histologic evidence of chronic cholecystitis and cholelithiasis occurred in 14 per cent of Wilkinson's cases, in 15 per cent of Polley's and in 17 per cent of Jones's.¹⁸

Carcinoma of the esophagus or stomach in combination with a hiatus hernia is uncommonly reported. In this series a midesophageal carcinoma in association with a hiatus hernia was the only malignant esophageal lesion. Whereas gastric carcinoma in combination with a hiatus hernia was diagnosed by roentgen ray in 4 cases, examination of the clinical records revealed that only 2 of the patients actually had carcinoma of the stomach. In the other 2 cases, in 1 operation and in 1 necropsy revealed that carcinoma was not present. In this series of patients with hiatus hernia there was, then, an incidence of gastric carcinoma of 0.65 per cent, as contrasted with an incidence of 3.48 per cent in the total number of patients studied. As with duodenal ulcer, this suggests that there may be some degree of protection afforded against the occurrence of carcinoma of the stomach by the presence of a hiatus hernia.

The foregoing data serve to indicate the degree of frequency with which associated gastrointestinal lesions occur in cases of hernia of the esophageal hiatus. The clinical importance of such findings is the point that must be repeatedly stressed on searching for and ruling out other gastrointestinal entities before symptoms are ascribed to a hiatus hernia. In a study of 50 patients with hiatus hernia, Radloff and King¹⁹ found one or more concomitant diseases in 69 per cent, the correction of which often afforded symptomatic relief.

COMMENT

There is little doubt that hiatus hernias, regardless of size, may be completely asymptomatic and may be demonstrated accidentally. This is the case in many instances in which accompanying lesions cause the symptoms. However, it is difficult to determine from the literature exactly how frequently hernias occur without symptoms. Wilkinson¹⁴ stated that in only 4 of his 70 cases were there no symptoms that could possibly be related to the hiatus hernia. Moersch²⁰ found that all but 19 of 246 patients with a hiatus hernia had symptoms directly attributable to the hernia. On the other hand, Root and Pritchett²¹

18. Jones, C. M.: Hiatal Esophageal Hernia, *New England J. Med.* **225**:963 (Dec. 18) 1941.

19. Radloff, F. F., and King, R. L.: Esophageal Hiatus Hernia, *Gastroenterology* **9**:249 (Sept.) 1947.

20. Moersch, H. J.: Hiatal Hernia, *Ann. Otol., Rhin. & Laryng.* **47**:754 (Sept.) 1938.

21. Root, J. C., and Pritchett, C. P.: Diaphragmatic Hernia, *Cleveland Clin. Quart.* **5**:203 (July) 1938.

stated that 19 of 31 patients with hiatus hernia had no symptoms referable to the hernia, but there were 14 associated gastrointestinal lesions in the asymptomatic group.

I have not been able to find in the literature a study of a sizable group of patients without gastrointestinal symptoms in the 50 to 70 age range in which roentgenologic examination for hiatus hernia specifically was undertaken. Such a report is required so that some idea of a control can be obtained to contrast with the available reports which are usually concerned with patients presenting symptoms of such a nature that roentgen examination of the gastrointestinal tract is indicated.

From the clinical point of view, the question of whether the presenting lesion is congenital or acquired is of no importance. The size of the hiatus hernia is also of little importance. This is stressed by Harrington⁴ and Jones,¹⁸ who pointed out that many of the symptoms occurred most frequently in patients with the smallest hernias.

TABLE 4.—*Distribution of Symptoms in 223 Patients (Modified from Jones¹⁸ and Ohler and Ritvo²²)*

Symptoms	No. of Cases	%
Epigastric pain	129	58
Nausea, vomiting or regurgitation.....	119	53
Heartburn	38	17
Dysphagia	18	8
Dyspnea	28	12
Substernal pain	63	28
Shoulder pain	42	18
Arm or hand pain.....	13	6

Table 4, modified from Jones¹⁸ and Ohler and Ritvo,²² presents the predominating symptoms in 223 carefully studied patients. There may be various combinations of symptoms, but in many cases one type of symptomatology predominates. Ritvo¹ stated the belief that the most typical complaint was a feeling of weight or pressure under the xiphoid process, which comes on during or soon after meals and is relieved by taking a hot drink or by walking about for a few minutes. Jones,¹⁸ in studying 45 patients with small hernias, found, as have others, that factors which may either precipitate or aggravate symptoms are exertion, emotional tension, the intake of excessive food and lying down. Somewhat typical is the tendency for symptoms to occur in attacks intermittently with periods of complete freedom. The physical examination is of little value in diagnosis. Methods of obtaining symptomatic relief were variable and included assumption of the upright position, vomiting, belching, the use of antacids and the use of atropine and nitroglycerin.

22. Ohler, W. R., and Ritvo, M.: Diaphragmatic (Hiatus) Hernia, *New England J. Med.* **229**:191 (July 29) 1943.

It is apparent that there is no pathognomonic pattern which the symptoms of hiatus hernia assume. Rather, its manifestations group themselves into syndromes, which may in an individual case simulate esophageal, gastric or duodenal, cholecystic and coronary artery disease as well as gastrointestinal bleeding and anemia of undetermined cause; this gives a good idea of the differential diagnostic problem.

In this study of roentgenologic findings in association with hiatus hernia, there was another diagnosis in 1 of every 4 cases. Clinical study would no doubt reveal that the hiatus hernia was a coincidental finding as regards the explanation of symptoms in some of these cases. On the other hand, the hiatus hernia should not be overlooked as a potential source of symptoms because another gastrointestinal lesion is present. Obviously, too, some of the associated lesions, such as duodenal and jejunal diverticula, are thought of as usually, but not always, being nonsymptomatic. There is no easy method of determining, in the presence of such combinations, which lesion is productive of the patient's symptoms, since either lesion alone may produce them. Observation and careful attention to the clinical course under treatment will usually uncover the answer to this perplexing problem.

SUMMARY

1. The relative frequency of hiatus hernia is indicated by presentation of 308 cases in which the diagnosis was made by roentgen ray in a two year period.

2. Hiatus hernia was the second commonest lesion diagnosed in this material by roentgenologic study of the upper part of the gastrointestinal tract. Duodenal ulcer was the most frequent diagnosis.

3. In 1 of every 4 cases of hiatus hernia there was roentgenologic diagnosis of an associated gastrointestinal lesion.

4. Careful evaluation of the clinical course is necessary to determine the part that hiatus hernia has in producing symptoms when an associated lesion is present.

DIFFERENTIAL DIAGNOSIS OF HIATUS HERNIA AND CORONARY ARTERY DISEASE

ARTHUR M. MASTER, M.D.

SIMON DACK, M.D.

JACOB STONE, M.D.

AND

ARTHUR GRISHMAN, M.D.

NEW YORK

IT IS THE purpose of this paper to emphasize the increasing incidence of hiatus hernia and coronary artery disease and to demonstrate that they may coexist, so that the presence of one condition does not exclude the other, and that by means of objective tests the presence of coronary disease can be ascertained and its relative importance properly evaluated. For those who wish to study the subject of hiatus hernia per se several earlier comprehensive reports should be consulted.¹

Although many use the terms hiatus hernia and diaphragmatic hernia interchangeably, in this report we will survey only herniation of the stomach through the esophageal opening of the diaphragm and not rupture through the diaphragm itself. The latter is far less common than hiatus hernia.

The differential diagnosis of hiatus hernia and angina pectoris due to coronary disease is of paramount importance. The diagnosis of hiatus

From the Cardiographic Department, the Mount Sinai Hospital.

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1. (a) Hedblom, C. A.: Diaphragmatic Hernia: A Study of Three Hundred and Seventy-Eight Cases in Which Operation Was Performed, *J. A. M. A.* **85**:947 (Sept. 26) 1925. (b) von Bergmann, G.: Das "epiphrenale Syndrom," seine Beziehung zur Angina pectoris und zum Kardiospasmus, *Deutsche med. Wchnschr.* **58**:605 (April 15) 1932. (c) Harrington, S. W., and Kirklin, B. R.: The Clinical and Roentgenologic Manifestations and Surgical Treatment of Diaphragmatic Hernia, with a Review of One Hundred and Thirty-One Cases, *Radiology* **30**:147 (Feb.) 1938. (d) Reid, W. D.: Hiatus Hernia Simulating Cardiac Infarction: Report of a Case, *New England J. Med.* **223**:50 (July 11) 1940. (e) Jones, C. M.: Hiatus Esophageal Hernia, with Special Reference to a Comparison of Its Symptoms with Those of Angina Pectoris, *ibid.* **225**:963 (Dec. 18) 1941. (f) Levy, M. D., and Duggan, L. B.: Hiatus Hernia of the Stomach: Incidence, Symptoms and Medical Management in 1,220 Gastro-Intestinal Cases, *South. M. J.* **34**:351 (April) 1941.

hernia has been made with increasing frequency.² Nuzum^{2c} actually discovered 25 instances of hiatus hernia in 100. consecutive cases of angina pectoris. He then studied roentgenologically another group of 957 patients and found hiatus hernia in 78 cases. Levy and Duggan^{1f} estimated that hiatus hernia was present in 2 to 3 per cent of all the cases in which roentgen study for gastrointestinal disease was made.

Coronary artery disease, too, is being detected with increasing frequency. Each annual United States census reports an increasing number of persons suffering from this illness. Master⁸ reported that in this country a half to one million attacks of coronary occlusion alone occur every year. We^{2d} have already emphasized the increasing incidence of both hiatus hernia and coronary disease. Actually hiatus hernia and coronary disease occur in the same age group, 40 to 70 years.⁴

It has long been known that hiatus hernia may produce pain in the chest which can simulate angina pectoris due to coronary disease.⁵ Herman and Singer^{5f} and Linn⁶ even observed simulation of coronary occlusion. Conversely, it is well known that coronary artery disease may be associated with symptoms referred to the gastrointestinal tract. Also,

2. (a) Cunha, F.: Recurrent "Hiatus Hernia" Syndrome of von Bergmann, *Am. J. Digest. Dis. & Nutrition* **1**:170 (May) 1934. (b) Moschowitz, E.: The Simultaneous Association of Hiatus Hernia and Coronary Disease, *J. Mt. Sinai Hosp.* **4**:272 (Nov.-Dec.) 1937. (c) Nuzum, R.: Hernia of Esophageal-Hiatus: Its Relationship to Angina Pectoris, *Am. Heart J.* **33**:724 (May) 1947. (d) Dack, S.; Stone, J.; Grishman, A., and Master, A. M.: Differential Diagnosis of Diaphragmatic Hernia and Coronary Heart Disease, *Bull. New York Acad. Med.* **24**:396 (June) 1948. (e) von Bergmann.^{1b} (f) Harrington.^{1c} (g) Levy and Duggan.^{1f}

3. Master, A. M.: Incidence of Acute Coronary Occlusion, *Am. Heart J.* **33**:135 (Feb.) 1947.

4. Jones.^{1e} Dack and others.^{2d}

5. (a) Jackson, D. E., and Jackson, H. L.: Experimental and Clinical Observations Regarding Angina Pectoris and Some Related Symptoms, *J. Lab. & Clin. Med.* **21**:993 (July) 1936. (b) Cossio, P., and Fustinoni, O.: Angina de pecho y hernia diafragmatica, *Rev. argent. de cardiol.* **9**:217 (Sept.-Oct.) 1942. (c) Porter, W. B.: Cardio-Diaphragmatic Syndrome, *Virginia M. Monthly* **70**:179 (April) 1943. (d) Beck, W., and Huffman, J.: The Importance of Diaphragmatic Hernia in the Differential Diagnosis of Coronary Artery Disease, *Stanford M. Bull.* **3**:181 (Nov.) 1945. (e) Clark, W. E.: Gastrointestinal Conditions Simulating or Aggravating Cardiovascular Disease, *J. A. M. A.* **128**:352 (June 2) 1945. (f) Herman, M., and Singer, E.: Para-Esophageal Hiatal Hernia: A Case Manifesting Gastrointestinal and Cardiac Symptoms and Presenting Itself on X-Ray as a Mediastinal Tumor, *New York State J. Med.* **46**:1020 (May 1) 1946. (g) von Bergmann.^{1b} (h) Harrington and Kirklin.^{1c} Cunha.^{2a} Dack and others.^{2d}

6. Linn, G. C.: Hiatus Hernia Confused with Coronary Thrombosis, *New York State J. Med.* **48**:303 (Feb. 1) 1948.

the two diseases may coexist.⁷ It is therefore obvious that the presence of one of these diseases does not exclude the other. To complicate the situation further, a patient may give no typical history of angina pectoris and yet suffer from coronary disease; and, on the other hand, in the absence of coronary disease a patient with hiatus hernia may present a typical anginal syndrome, with classic radiation of the pain to the left arm or the back, precipitated by effort, excitement or meals. Yet after operation on the hernia the symptoms have disappeared.⁸ Hence the history of the patient alone cannot be utilized as a means of diagnosis of either hiatus hernia or coronary artery disease.

It must be remembered that even in the presence of normal coronary arteries there are certain complications of hiatus hernia that may precipitate acute coronary insufficiency.⁹ The most important of these is hemorrhage from erosion or ulceration of the mucous membrane of the esophagus or the herniated stomach.¹⁰ With the decrease in hemoglobin, anoxia of the heart muscle may occur, producing changes in the electrocardiogram and even infarction of the left ventricle. In addition to hemorrhage, other complications of hiatus hernia which may occasionally occur are intense nausea, vomiting and dysentery. The patient often goes into peripheral vascular shock and acute coronary insufficiency may develop.

We have dwelt on the fact that hiatus hernia and angina pectoris may coexist and that similar symptoms may appear in each disease. The following symptoms, although more common in cases of angina pectoris, are found in both conditions: epigastric or substernal pain or

7. (a) Stubenbord, W. D.: Paroxysmal Auricular Fibrillation in Association with Hiatus Hernia: Report of a Case, *Ann. Int. Med.* **18**:406 (March) 1943. (b) Groedel, F. M.: Gastrointestinal Disorders Simulating Circulatory Disease and Vice Versa, *Am. J. Digest. Dis.* **12**:73 (March) 1945. (c) Radloff, F. F., and King, R. L.: Esophageal Hiatus Hernia, *Gastroenterology* **9**:249 (Sept.) 1947. Moschcowitz,^{2b} Nuzum,^{2c} Dack and others.^{2d}

8. Jones, C. M., and Chapman, W. P.: Studies on the Mechanism of the Pain of Angina Pectoris with Particular Relation to Hiatus Hernia, *Tr. A. Am. Physicians* **57**:139, 1942. Herman and Singer.^{5f} Linn.⁶

9. Master, A. M., and Jaffe, H. L.: (a) Coronary Insufficiency and Myocardial Necrosis Due to Acute Hemorrhage, *J. Mt. Sinai Hosp.* **7**:26 (May-June) 1940. (b) Master, A. M.; Gubner, R.; Dack, S., and Jaffe, H. L.: Differentiation of Acute Coronary Insufficiency with Myocardial Infarction from Coronary Occlusion, *Arch. Int. Med.* **67**:647 (March) 1941. (c) Master, A. M.; Jaffe, H. L.; Dack, S., and Grishman, A.: Coronary Occlusion, Coronary Insufficiency and Angina Pectoris, *Am. Heart J.* **27**:803 (June) 1944. (d) Master, A. M.; Dack, S.; Grishman, A.; Field, L. E., and Horn, H.: Acute Coronary Insufficiency: An Entity; Shock, Hemorrhage and Pulmonary Embolism as Factors in Its Production, *J. Mt. Sinai Hosp.* **14**:8 (May-June) 1947.

10. Bock, A. V.; Dulin, J. W., and Brooke, P. A.: Diaphragmatic Hernia and Secondary Anemia: Ten Cases, *New England J. Med.* **209**:615 and 624 (Sept. 28) 1933. Harrington and Kirklin.^{1c}

distress radiating to the left shoulder, aggravated by exertion and food and relieved by belching and by the use of nitroglycerin; indigestion, vomiting and other gastric symptoms. Nitroglycerin and often other antispasmodics will relieve the pain of both lesions.

The epigastric or thoracic pain or distress developing in the recumbent position or when the patient is bent forward and relieved by standing is characteristic of hiatus hernia. Moreover, the pain or pressure of hiatus hernia is apt to radiate to the right, and nitroglycerin does not relieve it as readily as atropine, belladonna and other antispasmodics and sedatives.¹⁰ The relation of body position to the symptomatology of hiatus hernia is not consistent. We are reminded of a man of 63 with severe coronary sclerosis whose attacks of angina pectoris were often precipitated or aggravated in the prone or sitting position and relieved by standing up. He died of myocardial infarction due to coronary insufficiency; at autopsy no hiatus hernia was found but only the severe coronary disease. It is clear, then, that objective tests of coronary disease are essential in distinguishing hiatus hernia and coronary disease, and for this reason we have made liberal use of the standard two step exercise test¹¹ and, to a lesser extent, of the 10 per cent anoxemia test.¹²

It has been known for a long time that reflexes arising from the diaphragm, esophagus, stomach or gallbladder, normal or diseased, may produce cardiac signs and symptoms and affect the coronary circulation.¹³

11. (a) Master, A. M.; Friedman, R., and Dack, S.: The Electrocardiogram After Standard Exercise as a Functional Test of the Heart, *Am. Heart J.* **24**:777 (Dec.) 1942. (b) Master, A. M.; Dack, S., and Jaffe, H. L.: Cardiac Efficiency and Prognosis Following Recovery from Acute Coronary Occlusion: The Results of Various Functional Tests, *J. A. M. A.* **120**:1271 (Dec. 19) 1942. (c) Master, A. M.; Nuzie, C.; Brown, R. C., and Parker, R. C., Jr.: The Electrocardiogram and the "Two-Step" Exercise: A Test of Cardiac Function and Coronary Insufficiency, *Am. J. M. Sc.* **207**:435 (April) 1944.

12. Levy, R. L.; Williams, N. E.; Bruenn, H. G., and Carr, H. A.: The "Anoxemia Test" in the Diagnosis of Coronary Insufficiency, *Am. Heart J.* **21**:634 (May) 1941.

13. (a) Schrager, V. L., and Ivy, A. C.: Symptoms Produced by Distention of the Gallbladder and Biliary Ducts, *Surg., Gynec. & Obst.* **47**:1 (July) 1928. (b) Roemheld, L.: The Treatment of the Gastrocardiac Syndrome (Gastric Cardiopathy), *Am. J. M. Sc.* **182**:13 (July) 1931. (c) Scott, H. G., and Ivy, A. C.: Viscerocardiac Reflexes: An Experimental Study in Frogs and Dogs, *Arch. Int. Med.* **49**:227 (Feb.) 1932. (d) Dietrich S., and Schwiegk, K.: Das Schmerzproblem der Angina pectoris, *Klin. Wchnschr.* **12**:135 (Jan. 28) 1933. (e) Hinrichsen, J., and Ivy, A. C.: Effect of Stimulation of Visceral Nerves on Coronary Flow in Dogs, *ibid.* **51**:932 (June) 1933. (f) Weiss, S., and Ferris, E. B., Jr.: Adams-Stokes' Syndrome with Transient Complete Heart Block of Vagovagal Reflex Origin: Mechanism and Treatment, *ibid.* **54**:931 (Dec.) 1934. (g) Greene, C. W.: Control of the Coronary Blood Flow by Reflexes Arising in Widely Distributed Regions of the Body, *Am. J. Physiol.* **113**:399 (Oct.) 1935. (h) Gilbert, N. C.: Vasomotor Changes in the Coronary Arteries and Their

This may apply particularly to hiatus hernia. The thoracic, phrenic, vagus and spinal nerve pathways are much the same for the diaphragm, lower end of the esophagus and stomach.¹⁴ It was thought that painful sensations arising from distention of the esophagus or herniated portion of the stomach or from the diaphragm were transmitted through these visceral afferent fibers to the upper thoracic spinal segments, from which they were referred to the precordium and the left arm. Miller¹⁵ has presented detailed descriptions of these nerve pathways which explain the radiation of pain to the sternum, precordium and left arm in hiatus hernia as well as in other thoracic and abdominal visceral diseases. Afferent pathways from the stomach, diaphragm and esophagus "may enter practically all the dorsal spinal routes and through these multiple afferent fibers . . . cardio-aortic and abdominal visceral references are mediated . . . the pain of these abdominal and pelvic conditions is focused in the heart and its immediate neighborhood and even overflows into the brachial and cervical plexuses."

Since the physiologic experiments of Dietrich and Schweigk^{13d} and Gilbert, Fenn and LeRoy,¹³ⁱ it has been assumed by some clinicians that hiatus hernia can produce pain in the chest by reflex vasoconstriction of the coronary arteries. The latter investigators observed diminution of coronary blood flow in dogs when the stomach was distended, a vagal reflex effect which could be abolished by vagotomy or atropinization. However, earlier experiments in dogs by Henrichson and Ivy^{13e} had failed to demonstrate any significant decrease in coronary blood flow following stimulation of the intact vagus nerve below the heart or excitation or distention of the upper abdominal viscera.

In an attempt to elucidate this problem by further clinical investigation, we decided to use the two step exercise and anoxemia tests on patients with hiatus hernia. The intensive application of these function tests has been of immeasurable help in attaining a more precise differential diagnosis of angina pectoris due to coronary insufficiency and of thoracic pain of noncardiac origin.

Possible Significance, J. A. M. A. **113**:1925 (Nov. 25) 1939. (i) Gilbert, N. C.; Fenn, G. K., and LeRoy, G. V.: The Effect of Distention of Abdominal Viscera on the Coronary Blood Flow and on Angina Pectoris, *ibid.* **115**: 1962 (Dec. 7) 1940. (j) Morrison, L. M., and Swalm, W. A.: Role of the Gastrointestinal Tract in Production of Cardiac Symptoms: Experimental and Clinical Observations, *ibid.* **114**:217 (Jan. 20) 1940. (k) Brown, C. F. G., and Dolkart, R. E.: The Significance of Gastrointestinal Tract Abnormalities as Related to the Management of Cardiac Disorders, *M. Clin. North America* **28**:107 (Jan.) 1944. von Bergmann.^{1b}

14. Jones.^{1e} Jackson and Jackson.^{5a} Porter.^{5c} Linn.⁶ Schragar and Ivy.^{13a} Weiss and Ferris.^{13f} Greene.^{13g} Morrison and Swalm.^{13j}

15. Miller, H. R.: (a) Angina Pectoris, Baltimore, Williams & Wilkins Company, 1939, pp. 132-136; (b) Central Autonomic Regulations in Health and Disease, New York, Grune & Stratton, Inc., 1942, p. 149.

MATERIAL AND METHODS

Fifty-seven patients with positive roentgenologic evidence of hiatus hernia were chosen for study. The majority of the patients were referred for roentgen examination because of their gastrointestinal symptoms, and the examinations were carried out in a routine fashion by the department of radiology.

The series comprised 31 men and 26 women, an almost equal distribution. The great majority were between 40 and 70 years of age; 3 were younger, and 2 were older.

To ascertain the presence or absence of organic heart disease the following clinical determinations were made: a complete history was obtained; physical, teleroentgenographic and roentgenoscopic examinations were made; the resting electrocardiogram including augmented unipolar extremity and Wilson precordial leads was obtained, and the two step exercise electrocardiogram and the 10 per cent anoxemia test were made.

The criterion for abnormality of the standard two step or double two step electrocardiogram¹¹ was the appearance after the exercise of RS-T depressions of 1 mm. or more or inversion or flattening of an upright T wave. The standard test was performed in 28 of the 32 patients whose resting electrocardiogram was normal. In 13 of the patients whose standard two step electrocardiogram was normal the test was repeated with double the number of trips called for in the standard tables, i. e., the double two step test.

The anoxemia test was performed on 16 of the 32 patients whose resting electrocardiogram was normal. This test consists of breathing a mixture of 10 per cent oxygen and 90 per cent nitrogen for twenty minutes. Our criteria for a positive reaction to the test were those described by Levy and his co-workers.¹²

RESULTS

The clinical findings and the results of the function test are recorded in the table. From the detailed history the patients were divided into four groups, as follows: group I, comprising 15 patients in whom only gastrointestinal symptoms were present (cases 1 to 15); group II, comprising 29 patients (cases 16 to 44) with both gastrointestinal and cardiac complaints; group III, comprising 3 patients (cases 45 to 47) whose presenting symptoms were chiefly cardiovascular, and group IV, comprising 10 patients (cases 48 to 57) with significant anemia whose symptoms were due to the anemia and to gastrointestinal disturbances.

In group I the chief complaints were entirely gastrointestinal in nature, namely, epigastric distress or pain, indigestion, difficulty in swallowing, regurgitation of food, substernal fulness, heartburn, nausea and vomiting. The symptoms were generally related to meals and were relieved on standing up. The cardiac investigation revealed no evidence of organic cardiac disease in 12 of the 15 patients. In 3 patients, however, despite the absence of cardiac symptoms, the presence of heart disease was demonstrated by left ventricular enlargement in 2 (cases 13 and 14) and an abnormal electrocardiogram in 1 (case 15). It was our impression that the heart disease in these 3 patients was not associated with any of the symptoms. In 4 other

Group I

No.	Case	Age	Sex	Gastrointestinal Symptoms	Cardiac Symptoms
1	E. S.	60	M	Epigastric distress, heartburn, vomiting	.....
2	S. T.	59	M	Nausea, vomiting blood	.....
3	V. W.	55	M	Epigastric distress, nausea, vomiting	Substernal pain, not on effort
4	I. B.	52	F	Epigastric pain, improved on standing or walking	Pain in left side of chest
5	G. B.	56	M	Dysphagia, nausea, vomiting	.....
6	C. S.	57	F	Epigastric distress, indigestion	.....
7	T. M.	75	F	Indigestion, nausea	Dyspnea, heaviness in chest, not on effort; auricular premature beats, hypertension
8	R. E.	58	F	.....	Pain in left side of chest on leaning forward and after meals
9	S. B.	50	M	Indigestion	Pain in left shoulder
10	M. C.	50	M	Indigestion, epigastric distress referred to right upper quadrant and right side of chest, relieved on standing	Ventricular premature beats
11	E. G.	44	M	Epigastric distress	.....
12	S. N.	46	M	Duodenal ulcer	Pressure on lower end of sternum, worse lying down, not on effort
13	H. Y.	68	M	Epigastric dysphagia, nausea, vomiting, worse lying down	Dyspnea, enlarged left ventricle
14	M. I.	40	F	Epigastric distress, relieved on standing or walking	Substernal pain, relieved on standing or walking. Ventricular premature beats, slight left ventricular enlargement
15	S. G.	71	M	Indigestion, dysphagia, nausea, vomiting	Auricular premature beats

Group II

16	C. R.	49	M	Indigestion, vomiting, dysphagia	Precordial pressure, worse after effort and meals
17	J. C.	46	M	Epigastric distress	Typical angina pectoris on effort, treated for coronary occlusion
18	B. Z.	60	M	Epigastric distress, heartburn	Retrosternal pressure, mild on effort
19	D. F.	38	M	Epigastric distress, indigestion, nausea, vomiting	Angina pectoris on effort, dyspnea
20	J. B.	37	F	Epigastric distress; gallbladder disease	Angina pectoris on effort
21	H. S.	49	M	Indigestion	Angina pectoris
22	T. T.	66	F	Dysphagia, regurgitation, substernal fullness	Old coronary occlusion; angina pectoris on effort
23	R. F.	50	F	Epigastric distress	Dyspnea, hypertension, enlarged left ventricle
24	B. H.	63	F	Abdominal discomfort, belching	Hypertension; auricular premature beats
25	J. P.	39	M	Belching	Pressure in chest, relieved on standing and walking; old coronary occlusion
26	B. M.	39	M	Belching	Substernal pressure on effort
27	B. R.	68	M	Peptic ulcer symptoms	Dyspnea
28	M. S.	72	F	Epigastric distress	Precordial pain on exertion, substernal burning, hypertension
29	E. G.	72	F	Nausea, vomiting blood, substernal burning	Substernal pain referred to back; dyspnea on effort
30	C. M.	47	M	Epigastric discomfort referred to left shoulder, worse lying down	Sharp substernal pain; treated twice for coronary occlusion
31	C. V.	72	F	Epigastric distress	Dyspnea, chest pain referred to epigastrium; syncope
32	M. F.	53	M	Epigastric distress	Typical angina pectoris, ventricular premature beats; treated for coronary occlusion; hypertension
33	H. W.	70	F	Indigestion	Paroxysmal auricular fibrillation, left ventricular enlargement, premature beats
34	H. R.	71	M	Heartburn, indigestion	Typical severe constricting precordial pain relieved on standing; left ventricular enlargement
35	R. O.	61	F	Epigastric distress, indigestion and heartburn	Substernal pain not on effort, with heartburn, hypertension, ventricular premature beat
36	B. P.	46	F	Epigastric distress, constant nocturnal aggravation	Dyspnea—pain worse on excitement
37	B. P.	45	F	Epigastric distress, nausea, vomiting blood	Typical angina pectoris on effort, hypertension, coronary occlusion
38	M. N.	71	M	Epigastric distress, indigestion, nausea, vomiting	Substernal pain, dyspnea, left ventricular enlargement
39	M. S.	63	F	Epigastric distress	Left ventricular enlargement, paroxysmal tachycardia, hypertension, angina pectoris on effort
40	J. B.	52	M	Epigastric distress	Typical angina pectoris on effort
41	J. V.	50	M	Indigestion, heartburn	Typical angina pectoris on exertion
42	E. S.	55	F	Indigestion, nausea, vomiting	Angina pectoris on effort, mild; paroxysmal auricular fibrillation, hypertension
43	G. B.	50	M	Epigastric distress, indigestion	Acute coronary occlusion
44	A. C.	51	F	Indigestion, duodenal ulcer	Angina pectoris on effort

Hernia and Coronary Disease

Electro- cardio- gram	Exercise Test, Standard	Exercise Test, Double	10% Oxygen Test	Hemo- globin	Associated Conditions	Organic Heart Disease	Comment
—	—	..	—	—	—	
—	—	79%	.....	—
—	—	—	Referred substernal pain	—	P-R interval, 0.21 second
—	—	—	Duodenal ulcer; referred pain in left shoulder	—	
—	—	—	—	—	—	
..	—	
—	—	—	—	—	Cardiac irregularity	—	
—	—	—	—	—	Referred pain in left side of chest	—	
—	—	..	—	—	Referred pain in left shoulder	—	
—	—	—	Cardiac irregularity	—	
—	—	—	—	
—	—	+	—	—	—	
..	73%	.....	+
..	75%	Substernal pain	+	
+	75%	Diverticulum of esophagus	+	
—	—	..	—	—	Neurocirculatory asthenia	—	
—	—	—	..	—	Typical angina pectoris	—	
—	—	..	—	—	Mild angina pectoris	—	
—	—	—	—	—	Pain in chest and left arm, bronchiectasis	—	
—	—	75%	Angina pectoris, gallbladder disease	—	
+	73%	Angina pectoris	—	
+	—	Coronary disease	+	Old coronary occlusion
+	—	Hypertension	+	Marked left axis deviation and high voltage electrocardiogram
+	Hypertension	+	Left axis deviation in electro- cardiogram
+	Coronary disease	+	Old coronary occlusion
+	+	+	..	—	Typical angina pectoris	+	
+	75%	Ulcer and coronary disease	+	
+	—	Coronary disease	+	
+	77%	Coronary disease	+	
+	—	Cardiac disease; referred sub- sternal pain	+	
+	—	+	Sinoauricular block; gallbladder disease
+	—	+	—	—	Coronary disease	+	
+	—	Coronary disease	+	Esophageal diverticulosis
+	—	Acute coronary occlusion	+	
—	+	..	+	—	Coronary disease	+	
+	—	..	—	65 to 78%	Angina pectoris	+	
+	—	Coronary disease	+	
+	—	Coronary disease	+	
+	—	Hypertension and coronary disease	+	
+	—	+	..	—	Coronary disease	+	
—	—	+	Acute coronary insufficiency, with abnormal electrocardiogram	+	
—	±	—	Angina pectoris	+	
+	—	Coronary disease	+	
—	—	+	—	—	Coronary disease	+	

Group III					
No.	Case	Age	Sex	Gastrointestinal Symptoms	Cardiac Symptoms
45	A. L.	50	M	.....	Typical angina pectoris on effort
46	R. R.	61	F	.....	Typical angina pectoris on effort; auricular fibrillation
47	J. C.	50	M	.....	Pressure above heart, not related to effort or meals, relieved on standing; auricular premature beats
Group IV					
48	I. F.	49	M	Epigastric pains relieved by standing up	Pain in left side of chest, not on effort or meals
49	R. B.	56	F	Epigastric distress, dysphagia, nausea, vomiting	Precordial and left shoulder pain, dyspnea, weakness
50	N. F.	77	M	Epigastric distress, duodenal ulcer	Retrosternal burning
51	A. M.	52	M	Tarry stools	Precordial pain, not on effort; dyspnea, weakness
52	L. B.	46	F	Epigastric distress, nausea, vomiting, relieved on standing	Dyspnea, ventricular premature beats
53	M. B.	58	F	Nausea, vomiting	Precordial pain referred to left shoulder, dyspnea, hypertension
54	C. F.	40	F	.....	Substernal pressure on effort; dyspnea; left ventricular enlargement
55	P. B.	56	M	Heartburn, vomiting blood	Hypertension, left ventricular enlargement
56	R. L.	68	F	Epigastric distress, heartburn, nausea, vomiting blood	Dyspnea, cardiac murmur
57	M. L.	52	F	Epigastric distress, nausea, vomiting	Pain referred to left shoulder; dyspnea

patients epigastric pain was referred to the chest or the left shoulder, but no evidence of coronary disease was elicited. The referred thoracic pain was generally vague in nature and was not related to effort but usually occurred after eating.

The largest subdivision was group II (cases 16 to 44), in which both gastrointestinal and cardiac symptoms were manifested. In addition to the usual symptoms of a gastrointestinal disturbance, there was pain or pressure in the substernal or precordial region, occurring spontaneously with or after exertion, palpitation, dyspnea and tachycardia. For example, in case 16 the chief complaint was indigestion and frequent vomiting, and yet there was also precordial pressure that was distinctly increased by effort. In case 17 the epigastric distress was related definitely to effort; the patient had been treated previously for coronary occlusion. In case 18, although heartburn and epigastric distress were frequent they did occur after mild effort. Similarly, in case 19, in which the chief complaints were epigastric distress, nausea and vomiting, the epigastric pressure bore a close relationship to effort and there was also shortness of breath on exertion. In 23 of this group of 29 patients cardiac disease was demonstrated by the objective examinations. Thus, in cases 22 to 25 inclusive the resting electrocardiogram was abnormal and, as a matter of fact, 2 of the patients had suffered coronary occlusion. Similar abnormalities were discovered in the remaining cases in which organic heart disease was listed. In 3 cases (cases 26, 41 and 44) the positive two step electrocardiogram was the only objective sign of organic heart disease. In 1 instance

Coronary Disease—Continued

Electro- cardio- gram	Exercise Test, Standard	Exercise Test, Double	10% Oxygen Test	Hemo- globin	Associated Conditions	Organic Heart Disease	Comment
+	+	+	..	—	Coronary disease	+	
—	—	Coronary disease	+	
—	+	+	—	—	Coronary disease, cardiac irregularity	+	
—	—	—	—	60%	Anemia, duodenal ulcer	—	
—	35%	Anemia and coronary insuffi- ciency	—	
—	39%	Anemia and referred pain	—	
—	—	—	—	34%	Anemia and coronary insuffi- ciency	—	
—	—	..	—	39%	Anemia	—	
—	27%	Severe anemia and coronary insufficiency	+	S-T depression in electrocardio- gram
—	45%	Moderate anemia and coronary insufficiency	+	
+	45%	Anemia and coronary insuffi- ciency	+	
+	28%	Severe anemia and coronary insufficiency	+	Gallbladder disease
+	57%	Anemia	+	

(case 35) the reaction to the 10 per cent oxygen test as well as to the two step test was positive.

In 6 patients (cases 16 to 21) whose symptoms were suggestive of cardiac disease the presence of the latter could not be confirmed by the objective tests or examinations. All 6 patients experienced retrosternal or precordial pressure or pain on effort in addition to their gastrointestinal complaints. Negative reactions to anoxemia and two step tests were obtained in 3 of these and negative reactions to two step tests in 2. The work-up was not considered complete in the remaining case, since these tests could not be performed. These 6 cases are of importance because organic coronary artery disease could not be demonstrated despite the history of a typical anginal syndrome on effort. Therefore, it is possible that in these cases the hiatus hernia was the only factor initiating the thoracic pain through the reflex pathways previously mentioned. We doubt whether reflex coronary vasoconstriction was an important precipitating factor, since no evidence of coronary insufficiency could be elicited by the function tests. It is more likely that the pain may have been referred from the esophagus or stomach to the thoracic wall without involvement of the coronary circulation.

There was a group of 3 cases (group III, cases 45, 46 and 47) in which only cardiac symptoms were present. The patient in case 45 had angina pectoris on effort; electrocardiograms at rest and after exercise were abnormal, but there were no gastrointestinal symptoms associated with hiatus hernia. The patient in case 46 had typical angina pectoris on effort, auricular fibrillation and an abnormal resting electrocardiogram.

The patient in case 47 experienced pressure over the heart which was unrelated to effort but was relieved by standing up. Premature beats were present, and the exercise electrocardiogram was abnormal. In none of these 3 patients would hiatus hernia have been suspected by history alone except perhaps in the last, in whom the thoracic pain was relieved in the upright position.

Group IV consisted of 10 patients (cases 48 to 57) who were anemic, the blood hemoglobin content ranging from 28 to 60 per cent of normal. The anemia was produced by chronic bleeding from the stomach. It generally was associated with symptoms referable to the cardiovascular system, such as dyspnea, weakness and precordial pain on effort, suggesting the presence of coronary insufficiency. In 5 patients (cases 53 to 57) the diagnosis of organic heart disease was established by the presence of abnormal electrocardiograms or cardiac enlargement. In 3 of the other 5 cases function tests were done and the results were negative, but they were performed after the anemia had disappeared. It is our impression that in all the patients of this group the anemia resulting from hemorrhage was the important factor in producing the cardiac symptoms, probably on the basis of coronary insufficiency. Correction of the anemia usually resulted in disappearance of the cardiac symptoms.

Cardiac irregularities were encountered in 14 patients. In order of frequency they were auricular premature beats in 5 patients, ventricular premature beats in 5, paroxysmal auricular fibrillation in 2, paroxysmal tachycardia in 1 and sinus arrest with nodal escape in 1. Two different arrhythmias were recorded in 2 patients (cases 33 and 42). All but 4 of the 14 patients were found to have other clinical evidence of organic heart disease in addition to the hiatus hernia. Nevertheless, it is possible that the hiatus hernia was important in initiating the arrhythmia. Reflex sinus arrest, heart block and auricular fibrillation have been observed in experimental distention of the esophagus^{13j} and in cardiospasm¹⁶ as a result of stimulation of, or pressure on, the vagus nerve. Stubenford^{7a} reported paroxysmal auricular fibrillation in a case of hiatus hernia and suggested that a search be made for this lesion in every case of paroxysmal auricular fibrillation. It is possible that the auricular and ventricular premature beats in our cases were also reflexly produced by the hiatus hernia.

REPORT OF CASES

The following short histories are illustrative both of the type of patient we encountered and of the points of distinction between hiatus hernia and coronary artery disease.

16. Iglaue, S., and Schwartz, B. A.: Heart-Block Periodically Induced by the Swallowing of Food in a Patient with Cardiospasm (Vagovagal Syncope), *Ann. Otol., Rhin. & Laryng.* 45:875 (Sept.) 1936. Weiss.^{13b}

CASE 8 (group I).—R. E., a 58 year old woman, complained of dull pain in the lower left anterior region of the chest on bending forward and after eating for at least seven years. There was also pain in the left arm. Neither the pain in the chest nor that in the arm was ever related to exertion. Physical examination of the chest and abdomen revealed no abnormalities. Roentgenologic examination of the stomach revealed a moderately large hiatus hernia, with a good portion of the stomach situated in the thorax (fig. 1*A*). The heart appeared normal in size and configuration. The electrocardiogram, including unipolar extremity and multiple precordial leads, was entirely normal. No significant change occurred after the standard and double two step exercise tests and the anoxemia test (fig. 1*B*). Pain in the chest did not appear during any of these function tests.

It is reasonable to expect that had the thoracic pain been due to coronary disease, evidence of it would have become manifest in seven years. Furthermore, the negative findings in the two step and anoxemia tests proved absence of coronary disease. The aggravation of the complaints on bending forward is characteristic of hiatus hernia.

CASE 41 (group II).—J. V., a man of 50 years, had experienced indigestion and heartburn for the past twenty years and precordial pain on effort during the past four months. Physical examination of the chest and abdomen was noncontributory. Roentgenologic examination revealed a short esophagus, with herniation of the stomach into the thorax (fig. 2*A*). The resting electrocardiogram was normal, but the double two step exercise test produced distinct depression of the RS-T segment in the standard and precordial leads, characteristic of coronary insufficiency on effort (fig. 2*B*).

It is apparent that in this patient the long-standing history of dyspepsia was associated with the hiatus hernia, but an anginal syndrome had developed recently on the basis of coronary artery sclerosis, a lesion unrelated to the hernia. The two step exercise electrocardiogram was essential for the diagnosis of coronary disease.

CASE 34 (group II).—H. R., a man of 71 years, presented a two week history of indigestion and heartburn relieved by alkali and bismuth powders. One week previously he began to experience precordial and substernal pain radiating through to the back, occurring spontaneously and also on walking. The pain was worse when lying down and was relieved by standing up. Since the character of the symptoms suggested the presence of hiatus hernia, roentgen examination of the gastrointestinal tract was carried out; this diagnosis was confirmed (fig. 3*A*). However, on the day of this examination a severe attack of constricting precordial pain developed. Severe precordial pain recurred during the next few days and was associated with the classic clinical signs of acute coronary occlusion with myocardial infarction, which was confirmed by serial electrocardiograms (fig. 3*B*) specific for this disease.

The clinical course in this case suggests that the patient was first seen during the premonitory phase of acute coronary occlusion. The resting electrocardiogram was pathognomonic of coronary occlusion.

From a practical point of view, it should be emphasized that in an elderly patient the manifestations of both hiatus hernia and severe coronary artery disease may develop simultaneously. The mere demonstration of the presence of hiatus hernia should not lead one to attribute all the symptoms to this one lesion.

CASE 17 (group II).—J. C., a 46 year old man, for twenty years experienced frequent heart attacks which were diagnosed as angina pectoris due to coronary disease. The attacks were unrelated to activity and consisted of substernal pain

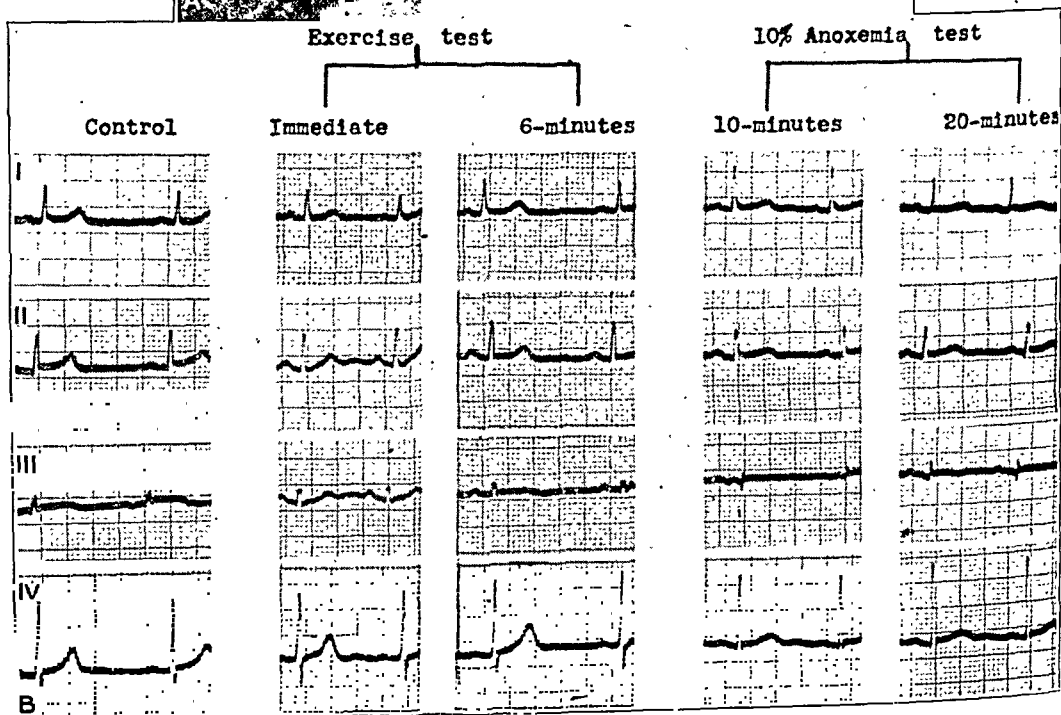


Fig. 1 (case 8).—*A*, moderately large hiatus hernia without organic heart disease. Dull pain in lower anterior region of chest after eating, but not related to exertion. No objective evidence of heart disease. *B*, normal electrocardiogram at rest and after standard two step and 10 per cent anoxemia tests.

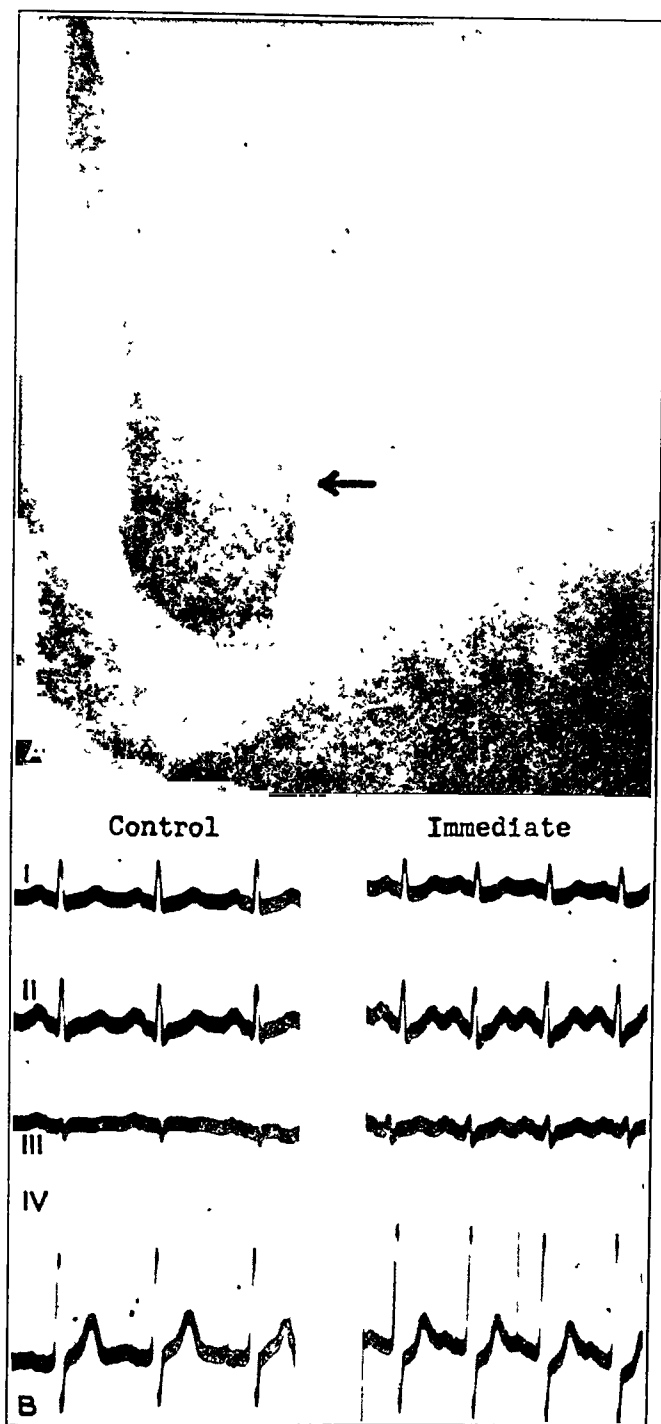


Fig. 2 (case 41).—*A*, small hiatus hernia and coronary artery disease. Indigestion for twenty years; precordial pain on effort for four months. *B*, control electrocardiogram normal. Positive reaction to standard two step exercise test (depression of RS-T segment), especially in precordial lead, indicating coronary insufficiency on effort due to coronary sclerosis

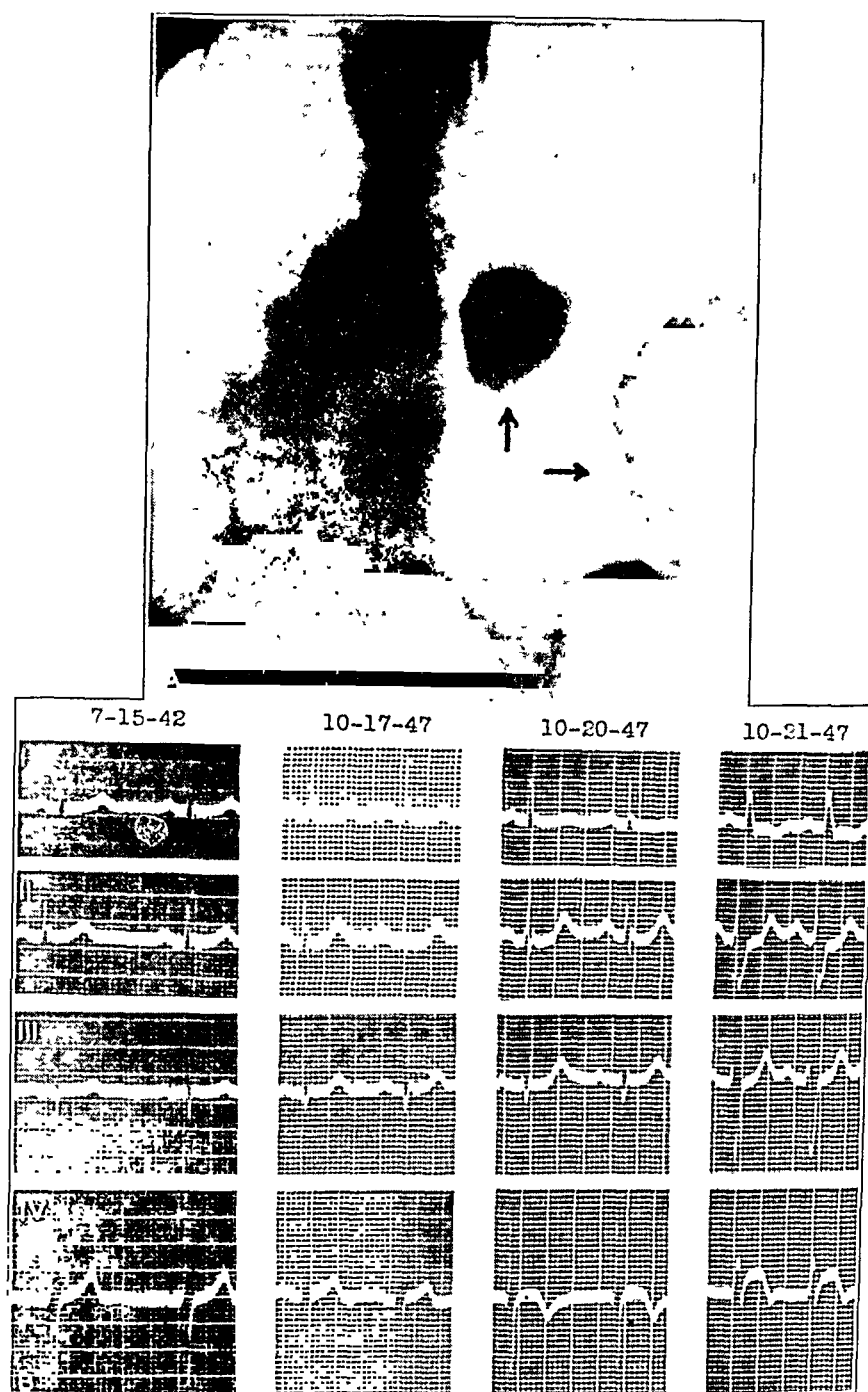


Fig. 3 (case 34).—*A*, moderate-sized hiatus hernia, demonstrated during premonitory phase of acute coronary occlusion. Indigestion and heartburn for two weeks; precordial and substernal pain for one week, relieved by standing. Acute coronary occlusion occurred day after roentgenologic examination of the stomach. *B*, electrocardiogram during premonitory phase (Oct. 17, 1947), normal and similar to old record of 1942. Subsequent tracings on October 20 and October 21 following an acute attack of thoracic pain show signs of infarction due to acute coronary occlusion.

and pressure radiating to the left shoulder and arm, lasting for several hours. Response to rest and the use of nitroglycerin was variable. Seven months before, after a severe attack of pain, the patient was hospitalized for six weeks and treated for acute coronary thrombosis. Weekly attacks of pain continued thereafter. Repeated electrocardiograms in the past were normal. During the past two years the patient had also experienced epigastric pain one hour after meals, relieved by milk and alkalis. A series of gastrointestinal roentgenograms had revealed a duodenal ulcer.

Physical examination of the cardiovascular system when the patient came under our observation was noncontributory except for moderately frequent ventricular premature beats. There was tenderness to deep epigastric pressure. Roentgenologic examination of the stomach revealed a hiatus hernia the size of a lemon (fig. 4*A*) and a markedly deformed duodenal bulb indicative of healed duodenal ulcer. The heart was normal in size and configuration, and the ventricular pulsations observed fluoroscopically were normal. The electrocardiogram, including multiple precordial leads, was entirely normal. No significant change occurred after the two step exercise test utilizing both the standard and the double number of trips (fig. 4*B*).

The absence of objective evidence of cardiac disease or coronary insufficiency in a man with a twenty year history of attacks simulating angina pectoris suggested that the hiatus hernia was responsible for the pain in the chest and left arm. It is likely that if coronary disease were present clinical evidence would become manifest after twenty years. Furthermore, the pain was not entirely typical of angina pectoris since it was unrelated to effort, was relieved by rest only after fifteen or twenty minutes, often lasted for several hours and responded to nitroglycerin infrequently. The normal two step exercise electrocardiogram ruled out the presence of organic coronary disease. The so-called "attack" of coronary thrombosis was in all probability an episode of pain from the hiatus hernia.

COMMENT

It is evident from our findings that uncomplicated hiatus hernia with few exceptions does not produce typical anginal pain on effort unless there is underlying coronary artery disease. If a patient with a known hiatus hernia experiences angina on effort, coronary artery disease should be suspected and will usually be confirmed by the two step exercise test.

We believe that in the past typical angina pectoris on effort has been attributed to a hiatus hernia too often because objective functional tests for coronary insufficiency were not carried out systematically. It is well known that in typical angina pectoris due to coronary artery sclerosis the physical and roentgenologic examination of the heart and the electrocardiogram may reveal no abnormalities in approximately one fourth of the cases. In order to confirm the diagnosis of coronary disease suggested by the symptoms, one must resort to the exercise or the anoxemia test. These tests will demonstrate the presence of coronary insufficiency when the thoracic pain is due to organic coronary disease. Our study further emphasizes the importance of utilizing these functional tests in patients with hiatus hernia who have referred thoracic pain.

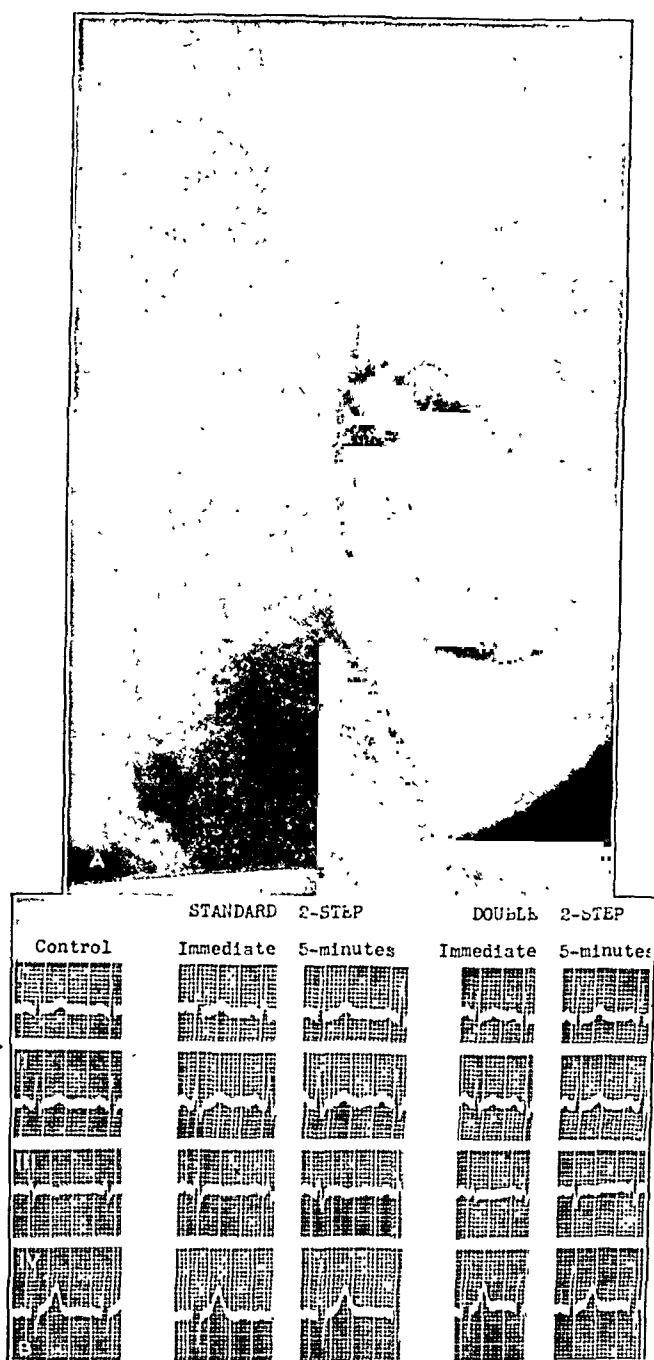


Fig. 4 (case 17).—*A*, hiatus hernia simulating angina pectoris and coronary occlusion. Recurrent substernal pain radiating to the left shoulder and arm for twenty years. *B*, electrocardiograms at rest and after standard and double two step exercise tests normal. The absence of objective signs of coronary insufficiency suggests that the pain is referred reflexly from the hernia to the chest.

We are of the opinion, after an extensive experience which has included thousands of tests with the two step exercise test and hundreds of trials with the 10 per cent oxygen test, that the two step test is much easier to perform and is safer. We have found no instance in which the 10 per cent oxygen test contributed additional information provided the double two step test was done when the standard two step test gave a negative result. Moreover, an occasional patient cannot complete the 10 per cent oxygen test but goes into collapse. If thoracic pain appears at all in the two step test it is likelier to be more severe in the anoxemia test. Finally, in some cases of coronary disease the reaction to the two step test will be positive when the reaction to the anoxemia test is negative.

There is no doubt that hiatus hernia can be associated with pain referred to the substernal and precordial region. As a rule, this pain is related not to effort but to meals and is not relieved promptly by rest or the use of nitroglycerin. It nearly always is accompanied with epigastric distress and indigestion. In only 6 of our cases in which the pain in the chest suggested a cardiac origin were we unable to elicit the objective signs of coronary disease. We concluded that in these patients the pain which simulated angina pectoris could have been produced solely by the hiatus hernia. In 3 of these patients, however, the cardiac work-up was not as complete as we desired.

Although we do not believe that hiatus hernia produces any disturbance in coronary circulation in the presence of normal coronary arteries, it is possible that it may act as a trigger mechanism in precipitating angina pectoris when the coronary arteries are sclerotic. A similar trigger mechanism has been demonstrated in the case of gallbladder disease. Stimuli through the upper abdominal visceral nerve pathways to the upper thoracic ganglions and spinal cord may be transmitted reflexly to the coronary arteries. The summation of such visceral stimuli and slight stimuli from the diseased coronary arteries may bring painful sensations in the thoracic wall to the conscious level. In the presence of normal coronary vessels, however, this mechanism must be rare unless another factor is present conducive to the development of coronary insufficiency, such as hemorrhage, anemia or shock. It is of interest that these factors of anemia, hemorrhage, shock, severe diarrhea and vomiting, which may occur in conjunction with hiatus hernia, are common precipitating factors of acute coronary insufficiency, particularly if coronary sclerosis is already present. Coexistence of the two conditions can be clearly verified in these cases, also, by the objective tests already enumerated.

SUMMARY

The differential diagnosis of hiatus hernia and coronary artery disease is of great practical importance, since hiatus hernia may produce symptoms simulating angina pectoris and occasionally acute coronary occlusion. The two conditions, which occur with increasing frequency in the same age group, may coexist; therefore, the finding of one does not exclude the other. •

An intensive study of the cardiac status was made in 57 consecutive patients with proved hiatus hernia of the stomach. The examination included a complete history and physical examination, teleoroentgenogram, roentgenoscopy, resting electrocardiogram including augmented unipolar limb and Wilson precordial leads, the two step exercise test and the 10 per cent anoxemia test.

Evidence of organic heart disease was found in almost two thirds of the cases. On the basis of symptoms the patients were divided into four groups: group I, 15 patients with purely gastrointestinal symptoms; group II, 29 patients with both gastrointestinal and cardiac complaints; group III, 3 patients with only cardiac complaints, and group IV, 10 patients with symptoms attributable to anemia secondary to hemorrhage.

Four patients of group I had pain referred to the left side of the chest, but no evidence of coronary disease was obtainable. In 23 of the 29 patients in group II cardiac disease was demonstrated by the objective examinations. In the 6 remaining patients with thoracic pain suggestive or characteristic of angina pectoris organic coronary disease could not be demonstrated, which suggested that the hiatus hernia may have been the only factor initiating the pain in the chest through reflex pathways. These negative findings in the latter cases also indicate that the history alone is not a safe means of differentiating hiatus hernia from angina pectoris due to coronary disease. Nevertheless, the history may be helpful, for the occurrence of epigastric or substernal discomfort in the recumbent position which is relieved on standing is characteristic of hiatus hernia, whereas constant relation to effort and prompt relief by the use of nitroglycerin is more suggestive of coronary artery disease.

Hiatus hernia not infrequently may precipitate coronary insufficiency even in the presence of normal coronary arteries if hemorrhage, severe anemia or shock develops.

CONCLUSIONS

1. Hiatus hernia and coronary artery disease can be distinguished from each other, and when they coexist the clinical importance of each can be properly evaluated.

2. This study emphasizes the value of objective functional tests for coronary insufficiency, especially the two step exercise test, in the dif-

ferentiation of these two conditions. A positive reaction to the two step test may be the only objective sign of coronary artery disease.

3. Although uncomplicated hiatus hernia does not produce typical anginal pain on effort unless there is associated coronary artery disease, exceptions do occur and objective functional tests are necessary for evaluation of the thoracic pain.

4. Hiatus hernia may produce pain referred through reflex autonomic pathways to the wall of the chest and the left arm. The functional tests in such instances do not yield evidence of coronary insufficiency.

ABSTRACT OF DISCUSSION

DR. RALPH C. BROWN, Chicago: These papers are timely. While a rather voluminous literature has appeared throughout the years, there is a lack of general awareness of the frequency of these hernias as well as of the important role they frequently play in diagnosis. My impression is that until recent years clinicians were inclined to disregard the small hernias so frequently seen in the course of roentgen examinations in which the Trendelenburg position and right and left turning of the patient, with simultaneous deep inspiration, were routine procedures. Our interest was concentrated more particularly on the large hernias causing dysphagia or hemorrhage or on the distress in the lower thoracic area associated with changes in posture.

However, between 1938 and 1943 a series of illuminating papers appeared, especially those of Moersch, Stuart, Harrington, Huber and Andresen and Chester Jones, and our diagnostic horizons were greatly enlarged. Harrington's survey showed that in 295 cases of diaphragmatic hernia in which he had operated there had previously been made an average of three erroneous diagnoses. In order of frequency these were cholecystitis, cholelithiasis, gastric ulcer, duodenal ulcer, hyperchlorhydria and anemia. However, we are still in need of facts from clinical, pathologic and roentegenologic sources. I think the majority of hiatus hernias are symptomless. Why do hernias of the same size and precisely the same appearance behave so differently?

Dr. Masters and his associates have made a detailed and exacting differential diagnostic study of coronary artery disease and hiatus hernias, and their conclusion that uncomplicated diaphragmatic hernia gives no objective evidence of coronary artery disease is a valuable observation. It seems probable that careful history taking, especially in regard to the conditions under which substernal pain arises, the area of radiation of pain, the effect of posture and, especially, of nitroglycerin, as well as electrocardiographic studies will limit to a relatively small group of cases those in which serious difficulty in differential diagnosis will arise. In Dr. Brick's series of 308 patients, 28 per cent had substernal pain or distress, whereas only 6 per cent had pain in the arm or hand; there is no information on how many in this 6 per cent group had radiation of pain to the flexor surface of the arm. In Chester Jones's 128 cases substernal pain occurred in 39 patients and pain in the arm or hand in only 12. The frequent association of coronary artery disease and hiatus hernia reported by Dr. Richards and Dr. Crockett emphasizes the importance of the technic of differential diagnosis described by Dr. Masters and his associates.

The data presented in Dr. Brick's statistical study are of great interest, especially those dealing with gastrointestinal lesions associated with hiatus hernia and with the fact that hiatus hernia was the second most common diagnosis made,

duodenal ulcer being first. I should like to ask Dr. Brick if he has any notes on the incidence of hemorrhage in his series and how many gastric ulcers were found in the herniated part of the stomach. Cases of hiatus hernia associated with either massive hemorrhage or slow, exsanguinating hemorrhage may present a difficult clinical problem, primarily because, in my experience, it is so difficult to visualize by roentgen ray the peptic ulcer which one suspects exists, probably at the point of greatest constriction, as the probable source of the hemorrhage.

DR. MANFRED KRAEMER, Newark, N. J.: My interest in diaphragmatic hernia began in 1933 when I saw a woman 54 years old who had a large hernia of the stomach on the left side and an equally large one of the colon through the right side of the diaphragm. These hernias had been discovered by Dr. Ernst May in 1927 and were reported by him in a radiologic journal. This was the first reported bilateral diaphragmatic hernia diagnosed by roentgen ray. Repair had been advised in 1927 and was again urged in 1933. She refused operation both times. She was an insurance broker and worked every day despite some substernal pressure. She was still able to work when I last heard of her in 1942. She was then 65 years old. So far as I know, she is still alive and carrying a good part of her colon and stomach in her chest. This case emphasizes that surgical treatment of diaphragmatic hernia need be resorted to only occasionally.

One most careful roentgenologic examination does not exclude the presence of a diaphragmatic hernia. In every case in which hernia is suspected and especially in unexplained cases of hemorrhage of the upper part of the intestinal tract we repeat our roentgen examination for hernia if none was found at the first examination.

The best position for demonstrating a diaphragmatic hernia is the prone Trendelenburg position, with the stomach full of barium sulfate suspension. We recently used both the prone Trendelenburg and the supine positions in a series of 600 consecutive cases. The prone position was the most accurate. In every case in which the hernia was demonstrated in the supine position it was also seen on the roentgenograms made in the prone position, but in several cases in which it was shown in the prone position it was missed in the supine position. Diaphragmatic hernia is often missed because a roentgenogram of the patient in the prone Trendelenburg position with a full stomach is not taken routinely in every gastrointestinal examination. Although there is a general impression that these hernias can be operated on only transthoracically, Dr. Edward Sprague has successfully repaired a number of them transabdominally. As there is often disease elsewhere in the abdomen, coexistent with diaphragmatic hernia, it is safer to use the abdominal approach and to explore the abdominal cavity before repairing the rupture.

DR. DONOVAN C. BROWNE, New Orleans: I wish only to stress one point, that these patients bleed and that this hemorrhage or bleeding may be exsanguinating. We have now had 6 of them in the gastroscopic clinic, in 4 of whom there was actually exsanguinating hemorrhage. Two of these were simply anemic and continued so. Among the 6 we have been able to demonstrate gastroscopically the bleeding points, and those doing the gastroscopy appreciate the difficulty and the rarity of this demonstration. The patients which we have had have all been beyond 60 years of age, and all have been obese.

DR. IRVING B. BRICK, Washington, D. C.: In answer to Dr. Browne's question, we have 5 patients among our 308 who showed an ulcer in situ or an ulcer of the hiatus hernia. As to incidence of hemorrhage, I am not able to give the figures in this series. However, in another similar study, Dr. Hampton and Dr. Sahler, at the Massachusetts General Hospital, reported that in 223 cases they found evidence of bleeding in 8 per cent. As to the question of asymptomaticity of these lesions, there is no doubt that hiatus hernias, either small or large, may occur in patients

who have no symptoms whatever and the presence of the hernia is a routine coincidental finding. However, there is not in the available literature a study of a sizable group of patients without gastrointestinal symptoms in the 50 to 70 age group in which specific roentgenologic examination for hiatus hernia was undertaken. Such a report is required so that some idea can be obtained to contrast with the incidence of hiatus hernia in patients who are having such symptoms that gastrointestinal examination is indicated. Such a study is certainly required so that we can get some idea of whether or not in the asymptomatic group of similar age the percentage of hiatus hernias is as high as in the symptomatic group. It is undoubtedly not as high, but there will probably be found a sizable percentage.

DR. ARTHUR M. MASTER, New York: Dr. Browne said that the history is of great value. It is probably the most valuable single differential point between hiatus hernia and coronary disease; yet I believe that the objective symptoms must be used frequently and sometimes one must depend on them solely. A very important differential sign is position of the body. In a patient with hiatus hernia the pain is worse on lying down or bending over and is relieved on standing up; but we advise patients with severe coronary disease not to bend over to tie their shoe laces since this frequently brings on their pain! I can go further and tell you the story of a man of 63 years of age, suffering from severe coronary disease, whose sternal pressure was induced by bending forward, whereas standing up and stretching relieved the pain. He died of a heart attack and was given postmortem examination. Severe coronary disease was found but no hiatus hernia. Similarly, patients with hiatus hernia may appear to be suffering from sclerosis of the coronary arteries. In the 57 cases we reported, many patients gave a distinct history of an anginal syndrome due to effort and yet they did not have coronary disease. They complained of pressure in the sternum while walking or climbing stairs, and yet we have shown that the only lesion from which they suffered was the hiatus hernia. A long follow-up has substantiated this. Hence, in summary, I repeat that although the history may be the most important single differential sign objective tests such as we have utilized are often necessary.

GRANULAR CELL MYOBLASTOMA OF THE ANTERIOR RECTUS SHEATH

SEYMOUR S. ROGERS, M.D.
GREENSBORO, N. C.

GRANULAR cell myoblastoma and rhabdomyoma are the two tumor types, both rare, arising from striated muscle cells. The myoblastomas were described originally as "Myoblastenmyome" by Abrikossoff¹ in 1926. At that time he regarded them as neoplasms due to faulty excessive regeneration subsequent to injury of striated muscle. In 1931, realizing that some of these tumors arose in areas devoid of striated muscle, he postulated² their origin from primitive myoblasts representing embryonal rests. He classified myoblastomas into four histopathologic types: (1) those consisting of granular myoblastic cells without the presence of striation, (2) the same type with the addition of occasional faint striations, (3) hypertrophic forms consisting of large multinucleated cells and (4) malignant myoblastic myomas consisting of pleomorphic cells, some areas showing differentiation and striations and others frankly sarcomatous in appearance.

On gross examination, myoblastomas are tumors varying in diameter from 0.5 to 2 cm., although they occasionally may be up to 10 cm. Some are well circumscribed or encapsulated, and others are poorly demarcated and may infiltrate into neighboring tissues.³ They are usually round but may be nodular or lobulated. The cut surface is firm, appears relatively avascular, is yellowish gray to pearly white and may present a finely lobulated appearance.

They consist, on microscopic examination, of large polygonal cells with deep-staining, vesicular nuclei, large amounts of granular and acidophilic cytoplasm and occasional protoplasmic processes of fibrils. Some of these cells may be rounded and others spindle or cylindric shaped. Mitosis is usually absent. On low magnification the cells appear to occur in groups, but under high power they lie in ribbon-like syncytial masses, with thin strands of connective tissue interspersed

From the Surgical Service, Hospital for Joint Diseases, New York.

1. Abrikossoff, A.: Ueber Myome, ausgehend von der quergestreiften willkürlichen Muskulature, *Virchows Arch. f. path. Anat.* **260**:215, 1926.

2. Abrikossoff, A.: Weitere Untersuchungen ueber Myoblastenmyome, *Virchows Arch. f. path. Anat.* **280**:723, 1931.

3. Crane, A. R., and Tremblay, R. G.: Myoblastoma, *Am. J. Path.* **21**:357 (March) 1945.

among many of them. These fibers in the stroma are characteristic, since they may be traced, on careful study, to the myoblasts.⁴ Cross or longitudinal striations are seen infrequently and, when apparent, according to Klemperer,⁵ are formed by a transverse arrangement of the granules at the periphery of the bands. Actually there is a strict separation of the muscle fibers and tumor cells. Occasionally granular cell myoblastomas are found in which the cells have large nuclei and are arranged in lobules separated by capillaries, giving the tumor the appearance of an endocrine gland, the so-called organoid type described by Horn and Stout⁶ and by Hartz.⁷ According to Stout,⁸ the only feature which distinguishes the malignant myoblastoma from the benign is a larger nucleus with a larger nucleolus. Even this feature may be lacking in the primary tumor and may appear only in the area of metastasis. Apparently there are no reliable characteristics of malignancy which are always present in the primary tumors. Howe and Warren⁹ described atypism of the cells, excessive mitotic figures, spindle-shaped cells and local invasion as signs of malignant myoblastomas.

Granular cell myoblastoma is differentiated from xanthoma by the fact that there is no fat in the former and from rhabdomyoma and rhabdomyosarcoma, which are composed of adult striated muscle elements.

Although myoblastoma is regarded as an essentially benign tumor, many cases of malignant myoblastomas have been reported. Geschickter⁴ described a case of myoblastoma in which metastasis developed five years after excision of the primary lesion. Howe and Warren⁹ in 1944 described 10 new cases of which 5 showed malignant properties, the tumor metastasizing to the lungs in 3 of the latter, and reviewed over 100 cases of which 11 per cent showed malignant characteristics. In 1947 Stout¹⁰ described two myoblastomatous tumors of the soft parts which metastasized and subsequently caused

4. Geschickter, C. F.: Tumors of Muscle, *Am. J. Cancer* **22**:378 (Oct.) 1934.

5. Klemperer, P.: Myoblastoma of the Striated Muscle, *Am. J. Cancer* **20**:324 (Feb.) 1934.

6. Horn, R. C., Jr., and Stout, A. P.: Granular Cell Myoblastoma, *Surg., Gynec. & Obst.* **76**:315 (March) 1943.

7. Hartz, P. H.: So-Called Granular Cell Myoblastoma of the Thigh With Organoid Structure, *Am. J. Clin. Path.* **14**:582 (Nov.) 1944.

8. Stout, A. P.: Granular Cell Myoblastoma of the Lumbar Region, *Texas State J. Med.* **41**:580 (March) 1946.

9. Howe, C. W., and Warren, S.: Myoblastoma, *Surgery* **16**:319 (Sept.) 1944.

10. Stout, A. P.: Sarcomas of the Soft Parts, *J. Missouri M. A.* **44**:329 (May) 1947.

death. In the same year Powell¹¹ reported 2 cases; in 1 the tumor metastasized from a subcutaneous nodule involving the ovaries and retroperitoneal tissues, and the other resulted fatally because of local invasion and erosion of a large blood vessel.

Myoblastomas may be found in almost any part of the body. In most of the cases reported and summarized in the literature the tumor was located in the tongue, skin, subcutaneous tissues including the breast,¹² muscles of the extremities, maxilla, lip, trachea or bronchi, ear, alveolar process and anus. Single cases have been reported in which it occurred in the bladder,¹³ esophagus, lacrimal sac, floor of the mouth, pharynx, spermatic cord, urethra, vulva, thoracic wall¹⁴ and the aponeurosis of the external oblique muscle.¹⁵ Those located under mucous membranes or skin have a decided tendency to be associated with hyperplasia and epidermoid carcinoma of the overlying epithelium.⁹

The following case is the first one reported in which the tumor occurred in the sheath of the rectus abdominis muscle. In this location it resembled clinically the more common desmoid tumor.

REPORT OF A CASE

In March 1947 a white man, 57 years of age, of Polish descent and a butcher by occupation, first noticed a small, hard, nontender lump in the anterior abdominal wall. He gave no preceding history of trauma. His family history and past history were noncontributory. The lump gradually increased in size. The patient entered the hospital in September 1947, and a wide excision of a scirrhus-like, fairly well demarcated tumor, about 2 cm. in diameter, located about 5 cm. below and 3 cm. to the left of the umbilicus and firmly attached to the anterior rectus sheath, was performed. The tumor, well covered with fat, was excised along with a generous margin of the anterior rectus sheath, the underlying segment of rectus muscle and local preperitoneal fat. Closure of the fascia was effected with alternating interrupted no. 2 chromic surgical gut and no. 30 stainless steel wire sutures. The postoperative course was uneventful, and the wound healed by primary union.

Pathologic Report.—Grossly, the specimen consisted of an irregular mass of fatty tissue from the panniculus adiposus, together with a strip of fascia of the rectus muscle on the under surface of the specimen and two fragments of muscle tissue from the rectus, deep to the tumor. Within the fatty tissue in one area there was a localized, but not well circumscribed, scirrhus tumor node. The latter measured approximately 2 cm. in its greatest diameter. The tumor sat on the

11. Powell, E. B.: Granular Cell Myoblastoma, *Arch. Path.* **42**:517 (Nov) 1946.

12. Simon, M. A.: Granular Cell Myoblastoma, *Am. J. Clin. Path.* **17**:302 (April) 1947.

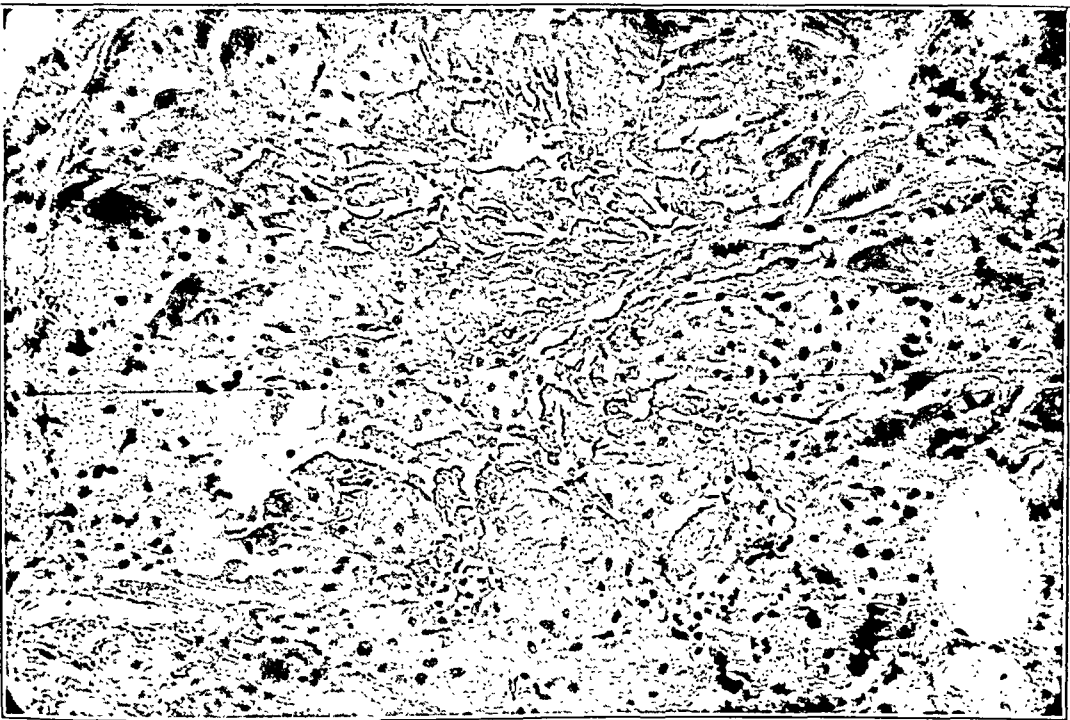
13. Ravich, A.; Stout, A. P., and Ravich, R. A.: Malignant Granular Cell Myoblastoma Involving the Urinary Bladder, *Ann. Surg.* **121**:361 (March) 1945.

14. Orr, T. G., Jr.: Myoblastoma: Case, *Ann. Surg.* **122**:122 (July) 1945.

15. Grayzel, D. M., and Friedman, H. H.: Myoblastoma of the Thoracic Wall, *Arch. Path.* **31**:512 (April) 1941.

fascial sheath and appeared to be infiltrating it locally, but there was no obvious gross evidence of penetration beneath it, nor was there gross evidence of extension of the tumor into the muscle fragments. The tumor tissue was mottled yellow gray in appearance and, as noted, was extremely hard.

Microscopically, the sections showed the tumor to be composed of lobules and strands of closely approximated cells with granular cytoplasm. The granular appearance of the cytoplasm did not reflect the presence of fat. The tumor lobules in places were separated by bands of collagenous connective tissue. At the periphery of the tumor the strands of connective tissue were invading the fat locally. The sections of the muscle tissue showed no evidence of extension of the tumor.



Photomicrograph showing tumor cells with small, deep-staining nuclei and granular cytoplasm. Hematoxylin and eosin; $\times 125$.

The tumor in question resembled a myoblastoma, even though it developed externally to the rectus sheath. The pathologic diagnosis was myoblastoma of the anterior abdominal wall.

COMMENT

In the case described the tumor may be classed as corresponding to the type I of Abrikossoff.¹ Its extramuscular location suggests its origin from an embryonal rest.

Some myoblastomas are true neoplasms, while others are considered as originating from a local degeneration of skeletal muscle. Geschickter⁴ expressed the opinion that the myoblastomas represent a phase in the histogenesis of voluntary muscle. He described the transition of this muscle from a syncytial stage in the mesenchyme to a myoblastic

stage and thence to a myofibrillar stage in which the developing fibers show first beading and then cross striations. In this last stage multinucleated cells are common. Stout⁸ stated the belief that some represent a development from undifferentiated mesenchymal cells of an abortive form of striated muscle cells. Such granular cells normally do not exist.

These tumors show no relationship to sex and may occur at all ages. However, they are most common in the third to fifth decade. Klemperer⁶ stated that they may occur at birth inasmuch as the so-called congenital epulis of the newborn is histologically a myoblastoma. He also stated that the male sex is more frequently affected, the ratio being about 2 to 1.

The treatment of choice is surgical extirpation. Recurrence may follow incomplete removal. These tumors are markedly radioresistant. Horn and Stout⁹ described a case in which a myoblastoma of the tongue survived a sufficient dose of radium to produce necrosis of the tongue. However, in general, the outlook is favorable. The great majority of granular cell myoblastomas are benign and do not recur after excision.

SUMMARY

1. Granular cell myoblastoma is a rare tumor arising from striated muscle cells.

2. It is regarded as an essentially benign tumor; however, malignant forms with local infiltration and distant metastasis have been described.

3. This tumor may occur in any part of the body, and when it is found in areas devoid of striated muscle its origin is thought to be from embryonal rests.

4. The treatment is surgical excision. The tumor is radioresistant.

5. A case of granular cell myoblastoma of the anterior rectus sheath, apparently arising from an embryonal rest, is described.

823 North Elm Street.

TREATMENT OF PEPTIC ULCERATION BY VASCULAR LIGATION

W. QUARRY WOOD, CH.M., F.R.C.S.E.
EDINBURGH, SCOTLAND

THERE appears to be little doubt that the fundamental factor in the production of peptic ulcer is the gastric juice, and there is an increasing body of evidence which suggests that it is the hydrochloric acid of the gastric secretion which is the element concerned. The gastric juice does not normally digest the stomach because it is buffered by the food and also by swallowed saliva, the secretion of the alkaline glands of the antrum and cardia and the regurgitation of duodenal secretion. The danger period occurs when the stomach is empty of food and especially during the hours of sleep. It is probable that patients who suffer from gastric or duodenal ulcer are the subjects of a derangement of gastric secretion, probably resulting from a functional nervous cause, as a result of which secretion of gastric juice is more profuse during the interdigestive periods than in the normal subject. In the normal person secretion during the night hours is scanty and the small amount of gastric juice is neutralized by saliva, duodenal secretion and alkaline antral secretion; in the person with ulcer the quantity of gastric juice secreted may be such that this neutralization is not possible and the mucosa is exposed to the action of pure gastric juice or of only partly diluted gastric juice. The brilliant American experimental work, especially that of Dragstedt, has shown that undiluted gastric juice will digest practically any kind of living tissue, and the histamine-wax experiments carried out in the University of Minnesota have demonstrated that if the secretion of gastric juice is kept up continuously chronic ulceration of the stomach and duodenum can be readily produced.

If these views are correct, it is natural that in the search for a cure for peptic ulceration the main object should be the cutting down of the quantity or of the acidity of the gastric juice. It is probable that in the not far distant future the physician will discover some means of doing this effectively, but in the meantime a certain proportion of cases resist his treatment and surgical measures are required. I shall not recapitulate the various phases through which the surgical treat-

ment of peptic ulceration has passed. In this country twenty-five years ago gastroenterostomy held the field; its place now has been taken by partial gastrectomy. The clinical results of gastroenterostomy were satisfactory in many cases, especially in those in which an organic stenosis was present. The failure of this operation has been due to the frequency with which it has been followed by ulceration of the jejunum, especially in young subjects with a patent pylorus and high gastric acidity. British surgeons were much slower in adopting gastrectomy in the treatment of peptic ulceration than those of America and the Continent, and many, I know, still have qualms about performing it in cases of duodenal ulcer in which the operation appears unnecessarily drastic for a lesion which is small in size and not particularly lethal. There can be no doubt, however, that the results of the operation are satisfactory in a large proportion of cases. It produces its effects mainly by removing a large part of the acid-secreting portion of the stomach, by removing the mucosa of the antrum, which is probably the source of a hormone concerned in gastric secretion, and by removing the site of ulceration. No doubt, the more rapid emptying of the stomach and the free regurgitation of intestinal juices are also beneficial.

I have said that qualms are still felt by some surgeons about the routine performance of this operation in the treatment of duodenal ulcer. These qualms are occasioned by the fact that the operation is a severe one and is bound to be attended by a certain mortality, which may be taken as being between 5 and 10 per cent. Secondary ulceration has not been completely eliminated, and secondary ulceration after gastrectomy is a much more formidable problem than that after gastroenterostomy. In addition, fears have been expressed about the effects of this operation on the patient's nutrition and vitality. How far these fears are justified does not seem to be definitely settled; the patients do not usually put on much weight after the operation, but the general health, as a rule, remains satisfactory. However, occasional cases of persistent anemia are met with, and attention has been directed recently to the incidence of hypoglycemia after meals, sometimes leading to loss of consciousness, this condition being due to dumping of the food in the upper coils of the small intestine because of the rapid evacuation of the stomach. As a result of these imperfections, the search for a better form of operative treatment still continues, and this has manifested itself from time to time by the introduction of such procedures as the various operations at the pylorus, the Connell fundusectomy, the Devine method of gastric exclusion and, recently, particularly by the revival of interest in vagotomy. Attempts have also been made to reduce the quantity and acidity of the gastric secretion by attacks on the blood vessels of the stomach. This procedure has only aroused interest in recent years and has

not yet been extensively tried out. The pioneer in this field was Hey,¹ of Manchester, but his only article on the subject was published in an American journal which I have only recently been able to obtain. Much work has been done by Somervell² on somewhat similar lines, and it is his method which I have employed in the cases on which I have to report.

Somervell first distinguished himself by climbing with a companion nearly to the top of Mount Everest and reaching a greater height without the help of oxygen than anyone has ever done. He then became a medical missionary in the south of India. In the region in which he worked duodenal ulcer was a common malady. He attributed this to the nature of the diet, which consisted mainly of rice and curry or tapioca and curry. Dietetic treatment outside the hospital was not possible owing to the extreme poverty of the native population, and the great majority of the patients with peptic ulcer were treated surgically. In 1936 he and a colleague reported 2,500 operations for gastric, duodenal and jejunal ulcers. He then performed gastroenterostomy as the routine operation for duodenal ulcer if there was stenosis or a normal or low acidity. In cases with a high acidity and no stenosis he performed a gastrectomy with pyloric exclusion after the Finsterer method, leaving the pyloric antrum and its mucosa. The mortality in gastrectomy for 81 cases of duodenal ulcer was 1.3 per cent. He has now performed over 2,000 operations for duodenal ulcer. Writing in 1942, he stated that he had been led to modify his operative procedure during the preceding five years. Instead of performing a partial gastrectomy in the cases with a high acidity he had adopted the procedure which he called a "physiological gastrectomy." In all cases with an acidity of the gastric juice of over 60 he treated the condition by ligation of a large proportion of the blood vessels of the stomach with the addition of a gastroenterostomy. In those with an acidity near the normal he performed a gastroenterostomy alone. It is interesting to note that he found the operation of gastroenterostomy a reliable method of reducing the gastric acidity in his patients. He found that the operation did not reduce the acidity immediately but did so effectively in the long run. His reason for adding the ligation of the gastric blood vessels to the gastroenterostomy was the fear of the development of stomal ulceration during the interval, possibly a year or eighteen months, which it took the gastroenterostomy to produce its effects. He found that if the gastric blood vessels were ligated as well the acidity dropped immediately and this obviated the risk of jejunal ulceration. He treated a few patients

1. Hey, W. H.: *Proc. Interst. Postgrad. M. A. North America*, 1937, p. 291.

2. Somervell, T. H., and Orr, I. M.: *Brit. J. Surg.* **24**:227, 1936. Somervell, T. H.: *ibid.* **30**:113, 1942; **33**:146, 1945.

by ligation of the blood vessels alone and obtained a satisfactory fall in the acidity in most of these, but he considered gastroenterostomy to be an essential part of the operative treatment. Among over 380 patients operated on by himself and his colleagues there was only one death. The operation consists in tying four of five or five of six of the blood vessels along the greater curvature from near the pylorus to the point where the left gastroepiploic artery reaches the stomach. This is done first on the anterior and then on the posterior surface after making a window in the mesocolon. On the lesser curvature all the vessels are tied except for one small vessel near each end of the curvature; this also is done on both anterior and posterior surfaces. He found that the resulting fall in acidity persists for at least five or six years. He suggested that this fall is due to the loss of blood supply, which causes the parietal cells to secrete less acid or possibly many of these cells to die or perhaps causes the hydrochloric acid to be secreted in a more dilute form. In other organs, when a proportion of the blood vessels are tied or destroyed, collateral channels enlarge and the blood supply is restored. Somervell suggested that this does not take place in the case of the stomach because the blood supply is already overadequate and after four fifths have been tied the remainder is sufficient for the stomach's needs without the necessity for dilation.

This seemed to me a method of treatment which ought to be tried out, and I performed the operation in 47 cases of duodenal ulcer and then stopped to await results. Most of the patients came from the medical side of the Royal Infirmary, and the majority had undergone a prolonged course of medical treatment. In all cases the vessels were tied as in Somervell's method and a gastroenterostomy performed. In cases with an acidity near the normal Somervell performs gastroenterostomy alone, but it was thought best to tie vessels in all cases as it seemed reasonable to believe that the ulcer would benefit from a fall in the acidity even when the acidity was within the normal limits before the operation. A fractional test meal was carried out before the operation and again at an interval of eight to twenty-one days after operation. The second test meal usually showed a definite fall in the acidity of the gastric juice, with complete achlorhydria in a few cases. At the end of 1946 a follow-up of 29 patients who had been operated on between December 1942 and June 1945 was carried out, that is, after an interval of from one and a half to four years. Twenty-four patients reported for examination, and 5 more replied to a questionnaire. Of the 24 reporting, 17 consented to a further test meal; 10 of these 17 had suffered from pyloric stenosis before operation, while in 7 there was no stenosis.

At the time of the investigation, November and December 1946, 27 of the 29 patients were back at full work. Twenty-seven reported themselves as free from gastric symptoms, but on more thorough questioning 2 admitted occasional heartburn and 4 said they occasionally vomited after a meal. Two were not working, 1 on account of a severe hematemesis two years after operation and 1 for some complaint unrelated to his gastric condition. Nearly all the patients had gained considerably in weight; 1 had gained as much as 56 pounds (25.4 Kg.), and 2 had gained 42 pounds (19 Kg.). The average gain in weight was 19 pounds (8.6 Kg.), and there was no great difference between those who had and those who did not have pyloric stenosis at the time of operation.

My first impression from this investigation was that the results of the operation were reasonably satisfactory, but further experience and the results of the late test meal have altered this opinion. In 2 of the patients in this group of 29 stomal ulceration has since developed, and they have been subjected to partial gastrectomy. In addition, a third patient, not included in the group, was operated on for the same condition, so that in this small series within four years from the time of operation there have already been 3 cases of jejunal ulceration. In the most recent of these cases and in a further case to be referred to presently special note was made of the appearance of the gastric blood vessels at the second operation. There was a definite diminution in the number of the vessels on the greater curvature, but on the lesser curvature fresh vessels had opened up and had taken the place of those which had been ligatured, so that the appearance of the vessels in this region did not differ appreciably from the normal. A recent patient was of special interest. He had been operated on by a colleague in 1932 for symptoms of duodenal ulcer. The record of this operation could not be traced, but, as was found later, it was either a mere exploration or a minor procedure at the pylorus. His symptoms soon recurred and were associated with attacks of hematemesis. He was treated in the medical wards on several occasions and was admitted there in February 1946 after a severe hematemesis. He then had high acidity of the gastric juice. The roentgenologic examination showed only slight deformity of the duodenal cap. I saw him then and advised further operative treatment. At operation I was unable to demonstrate a definite ulcer and I treated the patient by ligature of the gastric vessels alone, without gastroenterostomy. The test meal shortly after operation showed a considerable fall in the acidity. He remained well for six months, when his symptoms returned and he had three further attacks of bleeding. On investigation, about fifteen months after ligature of the gastric blood vessels, the acidity of the gastric juice was found to have risen almost to the preoperative level. At

a further operation on June 17, 1947, a cicatricial mass was found in the first part of the duodenum and partial gastrectomy was performed. This was an instructive case because it showed that the vascular ligation alone did not bring about a permanent reduction in the gastric acidity and did not protect the patient from further ulceration. The appearance of the gastric blood vessels was similar to that in the previous case; there was a diminution in the number of vessels on the greater curvature, but the vascularity of the lesser curvature did not differ appreciably from the normal owing to enlargement of collateral blood vessels. On section of the wall of the stomach, the vessels bled profusely and I had rather more trouble than usual in ensuring complete hemostasis at the suture line.

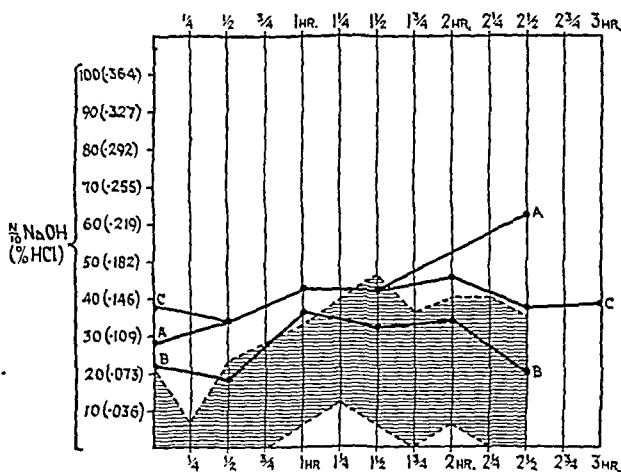
As regards the late effect of vascular ligation on the gastric acidity, 17 patients, as already mentioned, submitted to a further test meal which was carried out between one and a half and four years after operation. This showed that the acidity of the gastric juice had now returned almost exactly to the preoperative level. I was surprised that the gastroenterostomy by itself had not brought about a permanent reduction in the acidity. Somervell found in his Indian patients that this invariably took place, though it might be as long as a year or eighteen months before the full effect was produced. Heuer and Holman,³ of Cornell University, however, in a careful study of 75 American patients who had had gastroenterostomy performed, mostly for duodenal ulcer, found that 92 per cent showed free hydrochloric acid equal to and, in the large majority, greater than normal, so that the operation of gastroenterostomy must produce its beneficial results in some other way than by reducing the acidity, possibly by permitting more ready emptying of the stomach.

This operation of vascular ligation in my hands has therefore been a failure. There have been three stomal ulcers in 47 cases within four years of operation, ligation of the gastric blood vessels by itself in 1 case was soon followed by further trouble from ulceration and examination of the gastric juice after one and a half to four years showed that it had risen practically to the preoperative level. Inspection of the stomach at a second operation after an interval showed that fresh vessels had developed on the lesser curvature. It seems to me that the effects of this method of vascular ligation are only temporary and that fresh anastomotic vessels develop in the wall of the stomach so that there is no permanent reduction in the vascularity of the stomach. The beneficial effects of the operation in European patients are probably entirely due to the gastroenterostomy. The

3. Heuer, G. J., and Holman, C.: *Ann. Surg.* **118**:551, 1943.

liability to stomal ulceration is no less than after gastroenterostomy alone.

It remains to reconcile these results with the good results that Somervell was able to obtain. I have not had the privilege of seeing him perform this operation, and there may have been some defect in my technic. However, I followed his description of the method to the best of my ability, and in a proportion of cases, at least, the bluish cyanotic appearance of the stomach showed that its blood supply had been considerably reduced. It seems to me to be more likely that the Indian patients and the Scottish patients suffered from different types of the disease. Owing to the impossibility of applying medical treatment, Somervell operated on all patients with a high acidity who had had symptoms for more than a year, whereas our cases were of a chronic



Constructed curves from personal cases in which treatment was by Howard Somervell's method. A, before operation; B, eight to twenty-one days after operation; C, follow-up.

type, and many of the patients had undergone prolonged courses of medical treatment. In the cases in India, where the population lives on a diet of rice and curry, the dietetic factor may play the main part in the production of the ulcer, while in European patients the dietetic factor is probably less important than some other factor, possibly neurogenic. It may be that in the conditions present in the stomach in the Indian cases a diminution of the blood supply has a more striking and lasting effect.

In conclusion, I wish to refer to the method of Hey, which differs in several respects from the operation of Somervell. The primary object of Hey's method is a sympathetic denervation of the stomach so that the unopposed vagi may bring about more rapid emptying. In order to accomplish this, all the main vessels of the stomach are tied, and the effect is to bring about a more complete devascularization than that

obtained by the method of Somervell. Hey originally divided the blood vessels, but as a result of the work of Lee of Baltimore he now employs a quadruple ligature of linen thread or silk which is a more effective barrier to sympathetic regeneration than simple division. His work is based on about 150 animal experiments. All the arteries on both curvatures are tied from the esophagus to within an inch (2.54 cm.) of the pylorus. The pylorus and its neighborhood are left untouched on account of four or five vagal branches descending in the lesser omentum to the pylorus. A gastroenterostomy is performed in addition because of the tendency to the development of stenosis after healing of the ulcer. Hey regards the effects of the devascularization as only temporary. He finds that the acidity of the gastric juice is reduced for an average period of nine months and thereafter tends to rise, though probably not to the preoperative level. In a personal communication he has very kindly supplied me with the details of his method and informs me that he intends to publish the results in his first 500 cases before long. I am sure that these will be of great interest, and I wish to make it clear that my criticisms of the operation of which I have had personal experience have no application to the method of Hey, which is fundamentally different in principle.

ASPIRATION OF BLOOD FROM PERICARDIUM IN TREATMENT OF ACUTE CARDIAC TAMPONADE AFTER INJURY

Further Experience, with Report of Cases

MARK M. RAVITCH, M.D.

AND

ALFRED BLALOCK, M.D.

BALTIMORE

FIVE years ago we¹ reported our experience with the aspiration of blood from the pericardial cavity in the treatment of acute cardiac tamponade due to hemopericardium. At the time of our report, the results led us to the conclusion that aspiration of the pericardial contents is the treatment of choice for hemopericardium and that open operation should be resorted to only if bleeding continues or is resumed. Blau,² Anderson and Starbuck³ and others have reported successful results with nonoperative treatment.

Since our previous report, there has been an improvement in the mortality rate associated with the operative treatment of wounds of the heart. In 1944 Linder and Hodo⁴ reported a mortality of 43 per cent in 28 cases, a rate which is almost identical with Elkin's mortality of 42 per cent in 38 cases, reported in 1941.⁵ However, it is of interest that in the last 9 cases reported by Linder and Hodo there were no deaths, but that in 3 of them there was cardiac tamponade without any demonstrable wound of the heart itself. A subsequent report by Elkin⁶ is even more encouraging in that there was a mortality rate of only 22 per cent in 23 cases of stab wounds of the heart treated by operation. Part of the improvement was attributed by these observers to vigorous

From the Department of Surgery of the Johns Hopkins University and Hospital.

1. Blalock, A., and Ravitch, M. M.: A Consideration of the Nonoperative Treatment of Cardiac Tamponade Resulting from Wounds of the Heart, *Surgery* **14**:157 (Aug.) 1943.

2. Blau, M. H.: Wounds of the Heart, *Am. J. M. Sc.* **210**:252, 1945.

3. Anderson, H. M., and Starbuck, R. W.: Conservative Therapy of Cardiac Tamponade Resulting from Wounds of the Heart, *J. Florida M. A.* **33**:86, 1946.

4. Linder, H., and Hodo, H.: Stab Wounds of the Heart and Pericardium, *South. M. J.* **37**:261, 1944.

5. Elkin, D. C.: Diagnosis and Treatment of Cardiac Trauma, *Ann. Surg.* **114**:169, 1941.

6. Elkin, D. C.: Wounds of the Heart, *Ann. Surg.* **120**:187 (Dec.) 1944.

fluid replacement, the experimental basis for which was presented by Cooper, Stead and Warren.⁷

Since our last report, we have admitted to the hospital a total of 8 patients with cardiac tamponade due to wounds of the heart. Seven of these patients were treated by pericardial aspiration and the usual supportive measures. All survived without complications. The eighth patient was treated by primary cardiorrhaphy and recovered. An additional patient, shot through the heart, failed to respond to aspiration of 7 cc. of the pericardial blood and was thought not to have a tamponade. Exploration revealed a through and through wound of the heart, penetrating the right pulmonary hilus as well. He died of ventricular fibrillation. A patient with a stab wound of the neck bleeding into the left thoracic cavity was subjected to immediate thoracotomy. A wound of the left auricle was successfully sutured. The cases are recorded in detail later in this article, and the available data in 4 instances are presented in graphic charts. No other patients with heart wounds were admitted to the hospital during this period. Cases of patients who died in the accident room, and therefore were not admitted to the hospital, are discussed separately.

We continue to be impressed by the simplicity and regularly successful outcome of pericardial aspiration. Aspiration is performed in the left fourth or fifth interspace parasternally with a 16 or 18 gage needle. The quantity of blood in the 7 cases reported varied widely, from 12 to 305 cc. (the latter amount being obtained in two aspirations, four minutes apart). In all these cases there was an unequivocal cardiac tamponade. In some of them, as in case 4 (J. R.), in which the venous pressure did not reach a normal level for several days (fig. 2), it can safely be assumed that aspiration removed only a portion of the blood from the pericardial cavity. A salient feature of the treatment is the striking rapidity of clinical improvement after removal of blood from the pericardium.

Despite the excitement attending the arrival of such patients, every effort is made to carry out repeated observations on the arterial and venous pressures. The latter, in particular, has a specific diagnostic and prognostic significance. In most cases we have not felt justified in withholding blood or plasma in order to observe the effect of aspiration alone. J. S. (case 9), however, entered the accident room cold, sweating, pulseless and wildly restless, with unobtainable blood pressure, inaudible heart sounds and no cardiac pulsation visible with the fluoroscope. Aspiration of 12 cc. of blood from his pericardial cavity trans-

7. Cooper, F. W., Jr.; Stead, E. A., Jr., and Warren, J. V.: The Beneficial Effect of Intravenous Infusions in Acute Pericardial Tamponade, *ibid.* 120:822, 1944.

formed the clinical picture to one with blood pressure of 85 mm. systolic and 50 mm. diastolic (mercury), easily palpable pulse, audible heart sounds and cardiac pulsations plainly visible under the fluoroscope. Only then was the administration of blood plasma started. From a high point of 208 mm. of water prior to aspiration, the venous pressure fell gradually to 74 mm. of water in the next two and a half hours.

The usual clinical picture was that generally described. The standard signs of tamponade are low arterial pressure, elevated venous pressure, distant or absent heart sounds, decreased or absent cardiac pulsations as seen with the fluoroscope and the usual concomitant signs of shock. In addition, we find noteworthy the frequent occurrence of a relatively slow heart beat, when any is detectable, and the common occurrence of wild excitement in patients not completely prostrated. The electrocardiogram, even when taken in the first few minutes of treatment, has shown no specific change, except in case 11, in which the diagnosis of an injury of the coronary artery was made during life and demonstrated at autopsy. In several of the patients there subsequently developed some degree of hemothorax, which conceivably would indicate a leakage of pericardial fluid into the chest, preventing the delayed development of tamponade. It is particularly interesting that of the 8 cases, including case 11 (P. H.), in which tamponade was successfully treated by aspiration alone, 3 were of bullet wounds, 3 of knife wounds and only 2 were of ice pick wounds. The type of the weapon used to inflict the wound, therefore, need not affect the choice of treatment.

The possibility of cardiac tamponade is kept in mind in any case of a thoracic wound, particularly if it is precordial, and all such patients are closely watched. In case 1 signs of tamponade developed under observation during a period of almost two hours. Fluoroscopic examination and pericardial aspiration are the most helpful diagnostic measures. Arterial pressure and venous pressure should respond steadily after aspiration, and these, with the heart sounds and fluoroscopic findings, form the basis for evaluation of improvement. If improvement ceases or is not maintained at a satisfactory level, aspiration is repeated, as in case 8 (D. C.), in which 305 cc. of blood was aspirated in two attempts, 165 and 140 cc., respectively. If a second aspiration should fail to give relief, our plan is to take the patient to the operating room for cardiorrhaphy. The operating room is always alerted as soon as a patient with a wound of the heart is received in the accident department. It is our practice to take patients suspected of pericardial tamponade directly to the fluoroscopic room in the accident department and to perform all examination and treatment of the patient on the fluoroscopic table, with frequent observation of the heart. A needle is

at once placed in a peripheral vein, and administration of plasma is started prior to giving of whole blood. At times, dextrose injection in isotonic sodium chloride solution U. S. P. is injected preliminary to the administration of plasma. Administration of whole blood is continued until the patient's condition and blood pressure are stabilized at a satisfactory level. It would appear that in most cases of wounds of the heart which are not immediately fatal, bleeding is controlled and arrested by the tamponade and does not recur when the tamponade, which is now the life-threatening condition, is relieved by aspiration. Thus far we have seen no recurrence of symptoms of tamponade once the initial symptoms have been relieved.

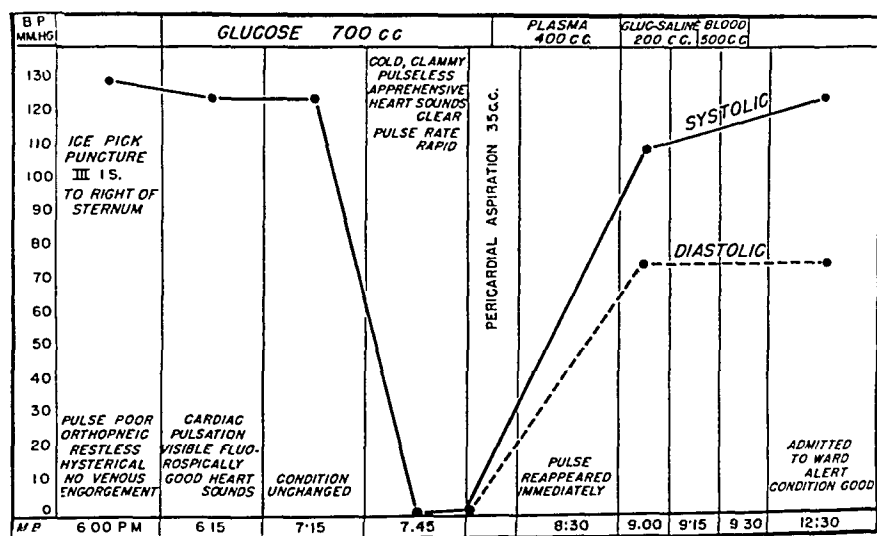


Fig. 1.—Graphic presentation of clinical data in case 1.

REPORT OF CASES

CASE 1.—M. B., a 17 year old Negro girl (fig. 1), was admitted to the accident room at 6 p. m. on July 16, 1942. She came to the hospital by car, upset and hysterical, stating that a short time before she had been stabbed in the chest with an ice pick. There was a small puncture wound in the third interspace on the right side beside the sternum. On admission, her blood pressure was 130 mm. systolic and 84 mm. diastolic. She had some discomfort when lying down, but no dyspnea. The heart sounds were of good quality, and cardiac pulsation was plainly visible fluoroscopically. There was no venous engorgement. Her condition remained unchanged for one hour and fifteen minutes of observation. Thirty minutes later she was heard moaning and was found to be cold, clammy and pulseless. Her heart rate was very rapid, but the sounds were of good quality. The arterial blood pressure could not be obtained. Fluids were given at once, and a pericardial aspiration, made in the fourth interspace on the left side, yielded 35 cc. of blood. A fairly good pulse returned at once, and the patient instantly felt greatly improved. She was given rapidly 500 cc. of plasma, 500 cc. of blood and

1,000 cc. of dextrose injection in isotonic sodium chloride solution U. S. P. Warmth quickly returned. Her blood pressure rose to 110 mm. of mercury systolic and 75 mm. diastolic and remained there. There was no evidence of either pneumothorax or hemothorax. An electrocardiogram, taken on July 17, was normal. For the duration of her one week stay in the hospital the patient was asymptomatic. She was last seen in December 1944, when she was thought to have schizophrenia, but otherwise appeared well.

Summary.—In a case of an ice pick wound of the heart, tamponade developed during observation and was relieved by aspiration of 35 cc. of blood from the pericardial cavity and the administration of 500 cc. of plasma, 500 cc. of blood and 1,000 cc. of dextrose injection in sodium chloride solution U. S. P.

CASE 2.—J. R., a Negro aged 20, was brought to the accident room at 7 a. m. on Feb. 14, 1943, fifteen minutes after having been shot in the chest. He was cold, pulseless and appeared to be moribund. There was a bullet wound in the third interspace to the left of the sternum. Aspiration of the pericardial contents yielded 7 cc. of blood, and faint heart sounds could be heard. The peripheral veins were not distended. The patient was thought to be in shock rather than to be suffering from tamponade, and unmatched group O blood was given at once. After the administration of 100 cc. of blood, his condition improved, and the blood transfusion was continued. The extremities became warm and the pulse palpable. The blood pressure rose to 100 mm. of mercury systolic and 70 mm. diastolic with continued transfusion, and he was sent to the ward. Coarse, bubbling rhonchi, heard all over the chest, suggested bleeding into the bronchial tree. The patient's condition remained static for about two hours, when his blood pressure again began to fall despite the administration of an additional 500 cc. of blood. With his blood pressure 80 mm. of mercury systolic and 20 mm. diastolic, he was taken to the operating room. He had thus far received 1,500 cc. of blood and 500 cc. of plasma. Although his general condition had improved greatly, he had never become conscious. The pericardium was exposed and had just been incised when the patient's pulse became imperceptible and the ventricles went into visible fibrillation. Neither administration of procaine hydrochloride, epinephrine and nikethamide (N,N-diethylpyridine-3-carboxamide) nor cardiac massage had any beneficial effect. A bullet wound of the right ventricle to the left of the pulmonary conus was sutured before the patient died, and there was observed another bullet wound, on the posterior surface of the right ventricle, which matched still a third hole in the pericardium on the right side, between the entrances of the venae cavae. It appeared that the latter wound probably relieved the tension of the potential cardiac tamponade and permitted the patient to survive as long as he did.

Summary.—In this case of perforating wound of the heart, the patient did not have tamponade. He died of ventricular fibrillation on the operating table.

CASE 3.—V. M., a Negro aged 21, was admitted to the accident room at 8:45 p. m. on March 24, 1944, about thirty minutes after he had been stabbed with a 3 inch (7.6 cm.) knife blade. He later told us that the blood had come out of the wound with great force and that he had walked a short distance and then collapsed. There was a stab wound in the fifth interspace just to the left of the sternum. He was pulseless; his blood pressure was unobtainable, and the heart

sounds were faint. On fluoroscopic examination, only faint cardiac pulsations were seen. The skin was cold and clammy, and the patient was perspiring profusely. He was irrational most of the time. Intravenous administration of fluids was started, but there was no improvement in his condition. Aspiration of the pericardial contents from below the xiphoid process yielded 15 cc. of blood. Fluoroscopic studies showed barely perceptible cardiac pulsations. Aspiration in the fifth interspace on the left side with a 16 gage needle yielded 100 cc. of dark blood, and the patient became quiet immediately. Pain in the calf of the left leg disappeared, and he fell asleep. The pulse became perceptible, and the blood pressure was 80 mm. of mercury systolic and 50 mm. diastolic at once. During the next hour, the blood pressure rose to 100 mm. of mercury systolic and 60 mm. diastolic, and a blood transfusion was given. Venous pressures taken in the accident room (time relation to therapy not stated) were 145, 165 and 175 mm. of water. The electrocardiogram on March 25 showed no abnormalities. Roent-

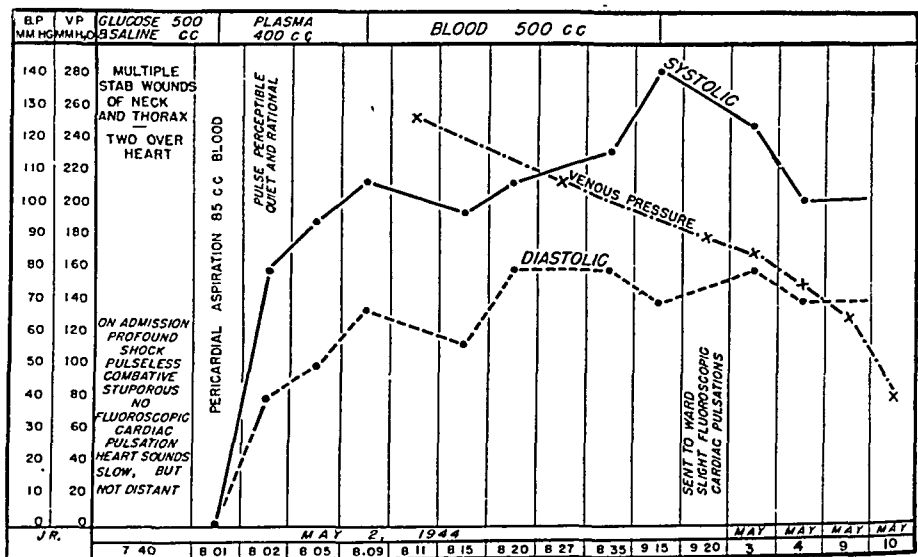


Fig. 2.—Graphic presentation of clinical data in case 4.

genograms showed a possible small effusion in the left pleural cavity. The patient was discharged on April 3, to remain in bed for three weeks. He failed to keep his return appointment.

Summary.—This patient had tamponade from a stab wound. Aspiration of 115 cc. of blood produced dramatic relief, which was maintained by the administration of 500 cc. of blood.

CASE 4.—J. R., a Negro aged 22 (fig. 2), was admitted to the accident room in profound shock at 7:40 p. m. on May 2, 1944, twenty-five minutes after receiving multiple stab wounds over the thorax and neck. The wounds were not bleeding severely, and the clothes were not blood soaked. The veins in the neck were distended. Two of the stab wounds were over the precordium; one was over the sternum at the level of the fourth interspace and appeared to have passed to the right. The patient was pulseless, and his blood pressure was unobtainable. The heart sounds were slow, but not distant. An intravenous injection of dextrose was given instantly, followed almost at once by plasma. On fluoroscopic examina-

tion, no cardiac pulsations could be seen. The patient was still pulseless, semi-conscious and combative. Aspiration yielded 85 cc. of blood from the pericardial cavity. His blood pressure immediately rose to 80 mm. of mercury systolic and 40 mm. diastolic, although it had been unobtainable immediately before aspiration. The patient became quiet and completely rational. The pulse was obtainable at the wrist. In the next hour and twenty minutes the blood pressure rose to 142 mm. of mercury systolic and 68 mm. diastolic and the pulse rate remained between 90 and 100. The first venous pressure reading, taken ten minutes after aspiration, was 253 mm. of water. Fifteen minutes later it was 213 mm. of water, and in another hour it had fallen to 185 mm. of water. By this time, an hour and twenty minutes after aspiration, fluoroscopic examination showed slight cardiac pulsations, and the patient was sent to the ward. Symptoms of cardiac tamponade had not recurred. The patient had received 400 cc. of plasma and 500 cc. of dextrose in saline solution by 8:05 p. m., at which time the administration of blood had been started. The pericardial aspiration was completed at 8:02 p. m., and the patient's blood pressure was then 80 mm. of mercury systolic and 40 mm. diastolic. By 8:45 p. m. 500 cc. of blood had been administered. His venous pressure was 170 mm. of water on May 3, 135 and 138 mm. of water on two observations on May 9 and 80 mm. of water on May 10. Roentgenograms of the chest showed no pleural fluid. Electrocardiograms, taken the following day, showed elevation of the S-T segments, which was construed as possibly representing pericarditis. These changes became less prominent in the electrocardiograms taken on May 5 and May 9. He was discharged from the hospital on May 12 with instructions to remain in bed for one week. He was last seen on May 19, apparently well.

Summary.—This patient had tamponade from a stab wound. Aspiration of 85 cc. of blood gave an immediate response. He received 500 cc. of blood, 400 cc. of blood plasma and 500 cc. of dextrose injection in isotonic sodium chloride solution U. S. P. His venous pressure continued to fall for several days, suggesting that some degree of tamponade had persisted.

CASE 5.—E. P., a 17 year old Negro youth, was brought to the accident room on Jan. 26, 1945, about ten minutes after he had been shot in the chest. At the time of admission he was pulseless, sweating profusely and agitated. The blood pressure was unobtainable. There was a bullet wound over the midsternum at the level of the second rib. Immediate fluoroscopic examination showed the bullet in the chest to the right of the midline about two interspaces below the point of entry. There were no visible cardiac pulsations. Slight venous distention was evident. Intravenous administration of dextrose injection in isotonic sodium chloride solution U. S. P. was started and immediately followed by injection of 250 cc. of plasma. At the end of twenty minutes the arterial blood pressure was obtained at 58 mm. of mercury systolic and 50 mm. diastolic, although the radial pulse was not palpable. Whole blood, 500 cc., was given at once. The venous pressure was then 195 mm. of water and rose in the next thirty minutes to 240 mm. of water. At this point pericardial aspiration was performed, and 160 cc. of blood was withdrawn. The radial pulse became obtainable at once, and cardiac pulsations became visible under the fluoroscope. The blood pressure was 72 mm. of mercury systolic and 54 mm. diastolic, and the pulse rate 125 when pericardial aspiration was performed and the blood transfusion started. Thirty minutes later the blood pressure was 114 mm. of mercury systolic and 76 mm. diastolic and the pulse rate 114. His condition being objectively and subjectively greatly improved, he

was transferred to the ward an hour and thirty minutes after he was first seen. The venous pressure was still 222 mm. of water. The next venous pressure, taken five hours later, was 145 mm. of water. His condition was stable thereafter. No electrocardiographic record was made at the time. Roentgenograms showed a moderate pleural effusion on the right. He was discharged fourteen days after admission. An electrocardiogram, taken on March 16, was recorded as normal. He was last seen in August and was still well.

Summary.—In a case of tamponade from a bullet wound, aspiration of 160 cc. of blood produced rapid improvement. The patient received 500 cc. of blood and 250 cc. of plasma. His venous pressure dropped slowly over a period of hours.

Case 6.—E. K., a Negro aged 42, was admitted to the accident room at 5:10 p. m. on July 5, 1945, fifteen minutes after having been stabbed with an ice pick. He was brought in by ambulance, prostrate, cold, sweaty and pale. There was a puncture wound in the fifth interspace, 1 cm. to the left of the midclavicular line. Fluids were administered intravenously and simultaneously 80 cc. of dark blood was withdrawn from the pericardium by aspiration. His blood pressure rose from 20 mm. of mercury systolic and 0 diastolic to 108 mm. of mercury systolic and 60 mm. diastolic and his venous pressure dropped from 250 to 140 mm. of water. His general condition improved remarkably, and he became responsive and cooperative. The response, as shown by the change in venous pressure and in his general condition, was almost immediate. At this point a transfusion of whole blood was started, and he was sent to the ward. No notation was made of cardiac pulsation. The electrocardiogram on July 14 was normal. On July 18 the roentgenogram for the first time showed fluid in the left side of the chest, and in the next two days a total of 575 cc. of pink fluid was removed. He was discharged on July 20, having been allowed out of bed for the first time on July 9. He was not seen after discharge.

Summary.—In a case of tamponade from an ice pick wound, aspiration of 80 cc. of blood produced almost instantaneous return to normal levels of all indexes to his condition, after which 500 cc. of blood was given.

Case 7.—W. A. P., a Negro aged 44, entered the accident room at 6 p. m. on Feb. 24, 1946, fifteen minutes after he had received multiple stab wounds of the chest and abdomen. He was comatose, without discernible pulse or blood pressure. There were two stab wounds in the fourth or fifth interspace just to the left of the sternum, several stab wounds elsewhere and a deep stab wound in the left flank. Heart sounds were inaudible. Administration of blood was started in the accident room, and the patient was taken at once to the operating room. Incision was made at 7 p. m., the heart being exposed transpleurally. A stab wound at the base of the right ventricle was bleeding briskly, and the pericardium was filled with clotted blood. With this blood evacuated and with the finger held in the heart wound, the pulse became strong and the blood pressure rose to 90 mm. of mercury systolic. The heart wound was sutured, and the thoracic wall closed. The abdomen was explored, and no visceral injury was found. The patient convalesced satisfactorily. Electrocardiograms on February 25 and March 14 were read as normal. The patient was discharged by ambulance on March 15, to remain in bed at home. He was last seen on April 22, apparently well.

Summary.—In a case of tamponade from a stab wound, primary cardiorrhaphy was followed by recovery.

CASE 8.—D. C., a Negro, aged 39 (fig. 3), entered the accident room at 10:55 p. m. on Jan. 14, 1947. He was pulseless, cold, sweating, combative and stuporous, fifteen to twenty minutes after he had been stabbed with a knife. There was a stab wound in the second interspace 2 cm. to the left of the sternum. The heart sounds were inaudible; respirations were rapid. The peripheral veins were moderately distended. Immediate fluoroscopic examination showed no visible cardiac pulsations. Pericardial aspiration through the fourth interspace on the left yielded 165 cc. of blood. The pulse appeared at the wrist for three or four minutes, and the heart sounds become barely audible. The venous pressure at 11:11 p. m. was 280 mm. of water. Plasma, 500 cc., was given intravenously. Another pericardial aspiration yielded 140 cc. of blood, a total of 305 cc. within sixteen minutes. Almost instantly the radial pulse was perceptible and strong, and cardiac pulsations

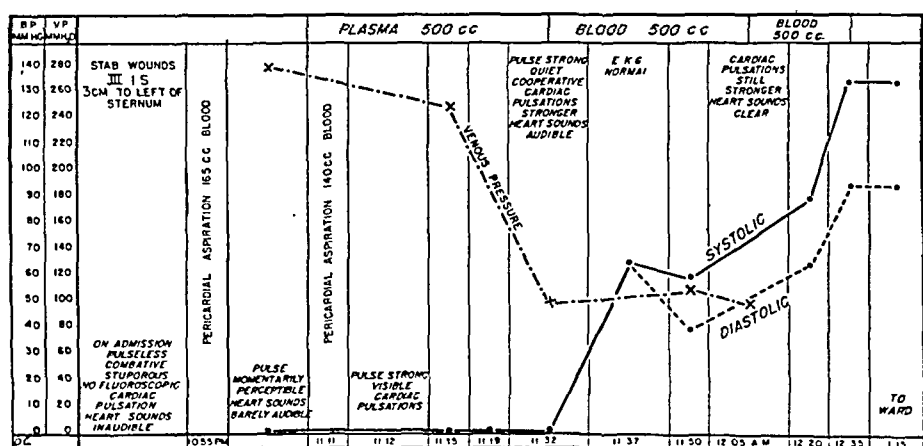


Fig. 3.—Graphic presentation of clinical data in case 8.

became visible on fluoroscopic examination. At 11:15 p. m. the venous pressure was 250 mm. of water. At 11:19 p. m. the pulse was 80 per minute; the blood pressure was still unobtainable. At 11:32 p. m., the extremities were dry, the pulse was strong and full and the patient was quiet. Fluoroscopic examination showed stronger cardiac pulsations, and the heart sounds were audible. The venous pressure was now 100 mm. of water, and the pulse rate, 90. The patient had received 500 cc. of plasma, which was now followed with 500 cc. of blood. At 11:37 p. m. his blood pressure was obtainable at 65 mm. of mercury systolic, and the respiratory rate was 26. The patient was quiet, rational and cooperative. It was remarked that from the beginning the heart had always appeared large under the fluoroscope, both to the right and to the left. An electrocardiogram was taken at 11:40 p. m. At 11:50 p. m. the pulse was 72, the venous pressure 110 mm. of water and the blood pressure 60 mm. of mercury systolic and 40 mm. diastolic. At 12:05 a. m., the patient was warm and dry, the cardiac pulsations were continuing to improve, the pulse was 62, the sounds at the apex were clear and the venous pressure was 100 mm. of water. The patient had received 500 cc. of blood, and administration of another 500 cc. was started. The systolic blood pressure was then 80 mm. of mercury. It

rose steadily, and at 12:35 the blood pressure was 135 mm. of mercury systolic and 95 mm. diastolic, the second 500 cc. of blood having been administered. The patient was admitted to the ward at 1:15 a. m. with a pulse rate of 80, a respiratory rate of 24 and a blood pressure of 135 mm. of mercury systolic and 90 mm. diastolic. During the next twenty-four hours his blood pressure steadily rose to a frankly hypertensive level, with the systolic pressure ranging from 150 to 170 mm. and the diastolic from 110 to 130 mm. From the time of his admission to the ward he improved steadily, with no return of the symptoms of tamponade. Roentgenograms of the chest failed to confirm the fluoroscopic impression of cardiac enlargement, but in the ward he showed consistent hypertension. The original electrocardiogram and two subsequent ones on January 17 and 27 were read as normal. The patient was up in a wheel chair on January 28 and was discharged on January 30. He was last seen in the outpatient department on February 3, when he stated that he had decided not to remain at rest, as instructed, and had resumed full activity. He was asymptomatic,

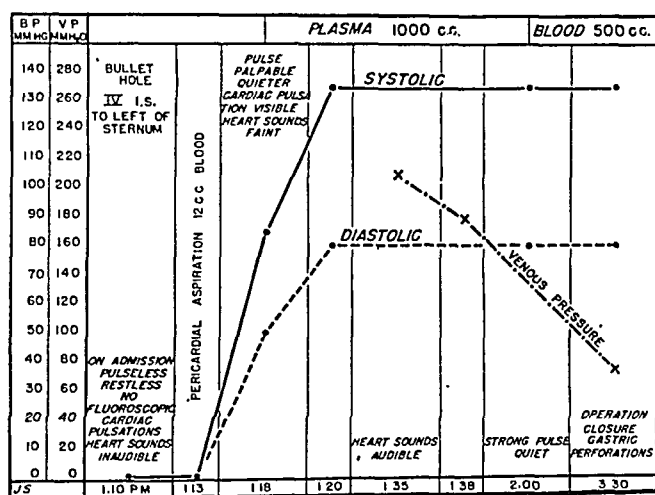


Fig. 4.—Graphic presentation of clinical data in case 9.

Summary.—In a case of tamponade from a stab wound, a total of 305 cc. of blood was aspirated from the pericardium over a period of sixteen minutes, at the end of which time improvement was rapid. The patient received 500 cc. of plasma and 1,000 cc. of blood.

CASE 9.—J. S., a Negro aged 29, with a long history of previous stab and bullet wounds was admitted to the accident room (fig. 4) at 1 p. m. on Feb. 12, 1947, fifteen minutes after having been shot in the chest. There was a small bullet hole in the fourth interspace on the left. He was cold, sweating, pulseless and wildly restless, but conscious and fairly cooperative. The blood pressure was not obtainable; under the fluoroscope, the heart was not seen to pulsate. Heart sounds were inaudible. Aspiration of 12 cc. of blood with a no. 18 needle through the fourth interspace to the left of the sternum produced dramatic relief. The pulse returned immediately, and cardiac pulsations became plainly visible under the fluoroscope, although the heart sounds still were not clear. The blood pressure rose at once to 85 mm. of mercury systolic and 50 mm. diastolic, and intravenous administration of plasma was begun. A .22 caliber bullet could be seen below

the left side of the diaphragm. By 1:20 p. m., his blood pressure was 135 mm. of mercury systolic and 80 mm. diastolic. At 1:38 the venous pressure reading was 180 mm. of water. By 2:00 p. m., he had received 1,000 cc. of plasma; his pulse was strong, and he was warm, dry and quiet. An electrocardiogram, taken at 2:15 p. m., showed changes in the T waves in precordial leads, interpreted as suggestive of myocardial damage in the region of the anterior part of the septum (inversion in CF_1 and CF_2 leads and diphasic in the CF_3 lead). His general condition remained unchanged, the arterial blood pressure holding at 135 mm. of mercury systolic and 80 diastolic and the venous pressure dropping to 74 mm. of water by 3:30 p. m. He was then taken to the operating room, where a through and through wound of the stomach was repaired. Little blood or soiling was found in the peritoneal cavity. After operation a moderate amount of fluid collected in the left pleural cavity. Convalescence was smooth, and he was discharged on February 23.

Summary.—In a case of cardiac tamponade from a bullet wound, aspiration of 12 cc. of blood produced immediate and dramatic response, after which 1,000 cc. of plasma was given.

CASE 10.—T. C., a Negro aged 37, was brought to the accident room on June 29, 1947, about thirty-five minutes after being stabbed in the neck, back and arms. He was conscious but in shock, with a blood pressure of 60 mm. of mercury, systolic and 40 mm. diastolic. There were two stab wounds at the base of the neck on the left. There was no external evidence of bleeding, but the left side of the chest was dull to percussion. It was thought that a wound of the great vessels was bleeding into the left side of the chest. The patient was given 1,000 cc. of plasma and 500 cc. of blood as preparations were made for the operation.

The chest was opened in the second interspace on the left side. A laceration 2 cm. in length in the left auricle was bleeding freely into the left side of the chest. The laceration was sutured while 3,500 cc. of blood was administered. The patient's blood pressure was unobtainable at several points in the procedure, but he was returned to the ward with a blood pressure of 138 mm. of mercury systolic and 80 mm. diastolic. He made an uneventful recovery. Electrocardiograms on June 30 and July 7, 9 and 11 showed low T waves and elevation of the S-T segments, changes which were interpreted as indicative of pericarditis. By July 15, prominent Q waves in lead II and large Q waves in lead III had developed. The patient was discharged on July 17, after having been up for four days.

Summary.—The patient had hemothorax from a stab wound of the left auricle, with the wound of entry in the neck. Cardiorrhaphy was followed by recovery. Immediate operation is the treatment of choice in such a case.

The 10 patients whose records have been presented were the only ones with heart wounds who were admitted to the hospital in the period under study. We have investigated the records of all patients pronounced dead in the accident room during the period in which the 10 patients whose records have just been described were seen. Among these were 31 patients with penetrating thoracic wounds, 20 of whom were dead on arrival at the hospital. Of the remaining 11 patients,

6 were found not to have wounds of the heart. This leaves 5 patients with wounds of the heart who died in the accident room and who are of interest in connection with the present report. The pertinent data in these 5 cases are presented in the table. It may be observed that

Clinical Data on Five Patients Who Died of Wounds of the Heart.

Accident Room Record					
Patient	Interval from Injury to Admission, Min.	Interval from Death, Min.	Wounds	Clinical Impression	Treatment
J. C.....	40	5	Stab, wound, right side of chest	Hemothorax, right; cardiac tamponade?	Intravenous administration of fluids; intracardiac injection of nikethamide; aspiration of 60 cc. blood from pericardium
J. H.....	15	5	Gunshot wound left side of chest posteriorly	Gunshot wound left side of chest	Died as intravenous injections of fluids and nikethamide were started
W. D.....	5	5	Stab wound left left side of chest	Cardiac tamponade; massive hemorrhage	Intravenous injection of fluids and plasma; nikethamide intracardially
E. S.....	Not known	55	Multiple stab wounds, chest	No penetrating wound of thorax	Plasma 1,300 cc. in 40 min.; pericardial aspiration of 8 cc. of blood; blood pressure 70/0 mm. Hg after 50 min.; venous pressure 270 mm. H ₂ O
P. H.....	Not known	120	Bullet wound left side of chest	Hemopericardium; injury to coronary artery (EKG)	Aspiration of 175 cc. of blood; 1,000 cc. of plasma and 300 cc. of blood administered intravenously; venous pressure then began to rise and patient died of cardiac failure

Medical Examiner's Report

Patient	Viscera Injured	Internal Loss of Blood	Heart Wound	Hemopericardium	Evaluation
J. C.....	Right lung, heart	2,500 cc. right pleural cavity	Right auricle	Not mentioned	Died of hemorrhage
J. H.....	Left lung, heart	750 cc. left pleural cavity; 375 cc. right pleural cavity	Left ventricle and interventricular septum	120 cc.	Died almost at once, probably of tamponade
W. D.....	Heart	2,500 cc. left pleural cavity	Apex of left ventricle	Not mentioned	Died of massive hemorrhage
E. S.....	Heart	1,250 cc. left pleural cavity	Pulmonary conus	90 cc. removed	Died of hemorrhage and tamponade; might have been saved had diagnosis been made on admission
P. H.....	Left lung, heart	800 cc. left pleural cavity	Myocardium of base of left ventricle; left anterior descending coronary artery	None removed	Died of heart failure after recovery from tamponade; missile injured coronary artery and caused infarct

J. C. had a stab wound in the right auricle and that there was bleeding into the right side of the pleural cavity. He was brought to the accident room forty minutes after injury and died almost at once. J. H. had a gunshot wound in the left ventricle and in the interventricular septum, with accompanying hemopericardium, and died almost as soon as he was

seen. W. D. died, almost at once of massive hemorrhage into the left side of the chest from a wound in the left ventricle. E. S. might have been saved by appropriate therapy. Autopsy revealed a wound of the pulmonary conus, 90 cc. of blood in the pericardium and 1,250 cc. in the left pleural cavity. His survival period in the accident room was fifty-five minutes, long enough to have permitted adequate aspiration therapy or operation. However, he had multiple stab wounds, none of which were thought to be penetrating. P. H. is of special interest; therefore his report follows in detail.

CASE 11.—P. H., a Negro aged 19, was brought into the accident room at 11:40 p. m. on May 24, 1947, shortly after having been shot in the left side of the chest. He was unconscious, cold and sweating. No pulse could be detected at the wrist. The heart sounds were inaudible, and cardiac pulsations were not visible under the fluoroscope. The blood pressure could not be obtained, but a feeble femoral pulse with a rate of 88 was detected on palpation. There was moderate venous distention. Administration of plasma was begun at once, and aspiration of the pericardial contents was made through the fifth interspace on the left side. After 80 cc. of blood had been removed, it was possible to hear the heart sounds, and his systolic blood pressure was 40 mm. of mercury ten minutes after admission. At 11:55, his venous pressure was 170 mm. of water; 500 cc. of plasma had been given, and a second injection of 500 cc. was begun. Fluoroscopic examination showed evidence of a small hemothorax on the left and a high, fixed diaphragm on the same side suggested injury to the phrenic nerve. At midnight, the cardiograph showed characteristic changes of a left anterior infarction. At 12:05 a. m., another aspiration was begun, and in three minutes an additional 95 cc. of blood was removed from the pericardium. At the beginning of this aspiration the venous pressure was 145 mm. of water, and at the end it was 128 mm. The patient became conscious, rational and interested in his condition. His previous history disclosed that in 1944, at the age of 15, he had been a patient in the Johns Hopkins hospital, where the diagnosis was combined mitral and aortic valvular disease. He stated that he had not recently been dyspneic. At 12:13 a. m. the venous pressure was 140 mm. of water and the blood pressure 70 mm. of mercury systolic and 44 mm. diastolic, and at 12:22 a. m., the venous pressure was 135 mm. of water and the arterial blood pressure 72 mm. of mercury systolic and 46 mm. diastolic. His pulse was strong with a rate of 96; the skin was warm and dry. He had had the second 500 cc. of plasma, and a transfusion of whole blood was begun. At 12:31, he had had about 200 cc. of blood; his blood pressure was 75 mm. of mercury systolic and 40 mm. diastolic, but the venous pressure had risen to 165 mm. of water. It occurred to us that his large rheumatic heart, further handicapped by the coronary infarction which the medical consultant (Dr. Witten) diagnosed, might have been overtaxed and failure of the right side of the heart was beginning. Accordingly, the rate of administration of the blood was greatly decreased, and the venous pressure then dropped for a time, being 158 mm. of water at 12:38 p. m. and 150 mm. of water at 12:39 p. m. At the same time, his blood pressure rose to 82 mm. of mercury systolic and 54 diastolic, and his face became warm and dry. In the next twenty minutes his venous pressure rose to 170 to 180 mm. of water, although his arterial blood pressure remained up. At 1:00 a. m. the arterial pressure was 84 mm. of mercury systolic and 54 mm. diastolic and his venous pressure 165 mm. of water. He had had 300 cc. of blood, when the transfusion was stopped. We thought that his recovery was assured and that he had come

blood in the pericardium which would be absorbed or would leak into the left side of the thorax. We felt that there might still be a moderate degree of tamponade and that there was probably injury of the left coronary artery, and perhaps of the phrenic nerve.

At 1:10 a. m., he was rational; his skin was warm and dry; his blood pressure was 100 mm. of mercury systolic and 60 mm. diastolic, his pulse was strong, and his heart sounds were clear. There was great difficulty in getting the venous pressure, which appeared to be incredibly elevated on each determination. At 1:21 a. m., the dehydrocholic acid ("decholin") circulation time was 8 seconds. At 1:30 a. m. the venous pressure was 240 mm. of water. This seemed so high that the test was repeated, but each successive determination gave a higher reading. In view of his good general condition, this was erroneously attributed to a technical error. Suddenly the patient gasped, rolled his eyes up, became pulseless, and, after a few gasps, when blood foamed at the nose and mouth, he died. Postmortem taps of both pleural cavities and of the pericardium yielded no blood.

We thought that the sudden death was due to cardiac failure from the coronary infarction.

Medical Examiner's Report.—Autopsy revealed 800 cc. of blood in the left pleural cavity, 200 cc. of clear transudate in the right pleural cavity and about 5 cc. of clotted blood in the pericardium. The right lung was edematous and heavy, weighing 700 Gm. and being filled with fluid, which bubbled out the bronchi. The left lung was atelectatic, and a bullet hole passed through the lower portion of the upper lobe. The heart seemed enlarged. There was a through and through wound of the myocardium of the left ventricle at the base, close to the coronary artery and not entering the chamber of the heart. The bullet was lodged in the sternum. The missile had transected the first branch of the anterior descending branch of the left coronary artery and produced a large hematoma in the myocardium and epicardium which appeared to have compressed the anterior descending branch of the left coronary artery. The myocardium in this area was whitish and dull, and its appearance was compatible with that of a fresh infarction. There was little evidence of rheumatic heart disease despite the previous history, but there was a fresh, fibrinous vegetation, 8 mm. in size, on the mitral valve. This appeared to be an active vegetation and was a purely coincidental finding. There was no right ventricular hypertrophy.

Comment.—This man recovered from his tamponade as a result of aspiration of 175 cc. of blood from the pericardium and died of cardiac failure due to injury to the coronary artery and traumatic infarction, probably hastened by intravenous therapy (1,000 cc. of plasma and 300 cc. of blood being given in seventy-five minutes). He did not require operative treatment, since the missile had not entered the heart chamber, and it may be said that his chance of recovery would not have been enhanced by operation. The diagnosis of infarction of the left anterior wall of the heart was made from the cardioscopic examination twenty minutes after the patient was first seen and should perhaps have been a warning against vigorous intravenous therapy.

Summary.—In this case, of pericardial tamponade due to a bullet wound, there was rapid response to aspiration of 175 cc. of blood. Death was due to pulmonary edema after 1,000 cc. of plasma and

300 cc. of blood had been administered. Autopsy showed no residual hemopericardium but revealed injury by the bullet to the anterior descending branch of the left coronary artery.

SUMMARY

Seven consecutive patients with pericardial tamponade due to hemopericardium were successfully treated by aspiration alone; 1 patient was successfully treated by immediate cardiorrhaphy, and 1 patient without tamponade died as a result of a perforating bullet wound of the heart and pulmonary hilus. One patient bleeding into the left side of the chest from a laceration of the left auricle was successfully treated by suture of the auricle. One patient with cardiac tamponade due to a bullet wound responded well to aspiration, only to die abruptly two hours after he was first seen. Autopsy showed division of the anterior descending branch of the left coronary artery, fresh infarction of the left ventricle and evidence of cardiac failure with pulmonary edema. Three additional patients died of heart wounds within five minutes of being admitted to the accident room. A fourth lived fifty-five minutes and might have been saved, but was thought not to have a penetrating wound.

Pericardial aspiration is the most important initial treatment for cardiac tamponade due to wounds of the heart. Facilities for open operation should be held in readiness, but it appears that with most wounds which cause cardiac tamponade, and are not immediately fatal, aspiration alone will suffice. Administration of blood and plasma is an important adjuvant.

NOTE—Since this report was submitted, 2 more patients have been treated for wounds of the heart. Both had tamponade, and both recovered.

The first patient, A. S., had a stab wound of the heart. Four pericardial aspirations over a space of fifty-five minutes yielded 773 cc. of blood, with dramatic recovery from a moribund state.

The second patient, C. C., had tamponade from a bullet wound. After 653 cc. of blood had been removed from the pericardium, in four aspirations, the patient was sent to the operating room for exploration of an abdominal bullet wound. His blood pressure was then 155 mm. of mercury systolic and 95 mm. diastolic, while the venous pressure was 230 mm. of water. With induction of anesthesia, arterial pressure fell sharply and venous pressure rose. Therefore, the pericardium, was aspirated of another 120 cc. of blood and a thoracotomy performed. There was a myocardial "increase," with one spurting vessel easily controlled by sutures. The abdomen was then explored, and perforations of the stomach were closed. He made a good recovery.

Johns Hopkins Hospital.

TETANUS TREATED AS A RESPIRATORY PROBLEM

VERNON C. TURNER, M.D.
AND
THOMAS C. GALLOWAY, M.D.
EVANSTON, ILL.

THE RECOGNITION of the importance of respiratory obstruction due to tracheal and pharyngeal secretion in certain conditions and the ability to control it have led to a completely changed prognosis in many diseases. This has been true especially in bulbar poliomyelitis.¹ During the year 1947 no patient with anterior poliomyelitis died at the Evanston Hospital although there were 60 cases, 7 of which were of the bulbar type. Five of these required tracheotomy. One patient with myasthenia gravis, accumulation of throat secretions and impending asphyxia was treated on the same basis, with rapid relief.

Certain other states would seem to have the same common denominator of respiratory obstruction, anoxia, respiratory weakness and danger of drowning from aspirated secretion. We thought that tetanus, with convulsions under control by curare, would present much the same picture and respond to the same measures. When a patient with severe tetanus came under our care we found in fact that she did respond to the treatment on this basis so remarkably that we believe it could be applied to most cases of severe tetanus with satisfactory results. The treatment was found to be relatively simple and seemed in retrospect to be so logical and dependable that it should be adaptable to most serious infections with tetanus.

Curare has been used in the treatment of tetanus since 1894, as reported by Cullen.² Tracheotomy was advised for grave emergencies by Spaeth.³ Isacson and Swenson⁴ used a respirator with apparent benefit but without recovery in 1 case of tetanus. Tracheotomy was not done. So far we have not found in the literature that the three measures have been combined in any case. This, we believe, may be necessary for the reasons to be discussed.

From Northwestern University School of Medicine and Evanston Hospital.

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In bulbar poliomyelitis it is found that if the airway is cleared and kept clear by aspiration, postural drainage and, when necessary, tracheotomy or the use of the respirator or both most patients will recover. The improvement may be so rapid—a matter of minutes at times—that it indicates that the associated depression is much more likely to have been secondary to anoxia (or carbon dioxide accumulation) of peripheral respiratory origin than to infection. It seems also definitely to be indicated that in a patient in whom respiratory weakness, paralysis or drug action makes it necessary to use a respirator, if the secretion cannot be positively and constantly eliminated, tracheotomy must first be done. Why this is so was shown previously in a discussion of poliomyelitis.¹

REPORT OF A CASE

On July 2, 1946, operations were performed on both knees of a 17 year old girl for recurrent congenital dislocation of the patellae. The operative wounds healed without difficulty, and the patient returned to full activity. Late in February 1947 a small ulcer developed in the proximal end of the operative scar on the left side. This developed into cellulitis of the thigh. The patient was admitted to the hospital at that time, and the inflammation subsided under complete bed rest, elevation of the extremity, hot compresses and administration of penicillin. Culture of material from the wound showed hemolytic staphylococci and hemolytic streptococci. She was discharged from the hospital wearing a small dressing over the nearly healed ulcer.

She was seen again on March 25, 1947, with an acute flare-up of the inflammation about the proximal end of the incision and with a small ulcer in the scar. She was again hospitalized and treated as at the time of the previous admission. Material from the wound was cultured, and it was inspected with a gloved finger. It was about 2.5 cm. in diameter and 2 cm. deep. The walls were smooth, and there were no pockets. Three days after admission symptoms of tetanus developed. After recovery, when she could be questioned, the patient stated that she had gone horseback riding ten days prior to the last admission to the hospital, and this may represent the time of introduction of the organisms into the wound.

Material from the wound was cultured on two occasions, and the tetanus bacilli were not found. However, the organisms are difficult to culture from such a wound, and there can be little doubt that the diagnosis of tetanus was correct, because the clinical manifestations were so marked and typical. The symptoms included an elevation of temperature, rigidity of the back and neck with opisthotonos, trismus, frothing at the mouth, difficulty in breathing, difficulty in swallowing, inability to open the mouth, production of stringy, frothy viscous secretions and acute, generalized tonic spasms or convulsions.

As soon as the diagnosis of tetanus was made, the patient was given 80,000 units of tetanus antitoxin intravenously and 20,000 units locally about the ulcer. Luminal sodium[®] (phenobarbital) was used for sedation, but because the spasms became increasingly severe she was given 60 units of curare,¹ in the form of intocostin,[®] intravenously. Administration of oxygen, 6 liters per minute by nasal catheter, was started. At the time the curare was given the stimulus of inserting a needle set off a tonic convulsion, during which the opisthotonos became extreme and respirations ceased for a half-minute at a time because of the spasm of the abdomen and chest. The effect of the intravenous administration of curare was dramatic: the opisthotonos decreased until it was possible for the patient to lie flat on the table; the jaw became relaxed, as did the skeletal muscles, and there was a release of the spasm of the respiratory muscles, so that more normal breathing was possible. However, when the effect of the curare was at its height, flaccid respiratory paralysis was noted, and it was necessary to insert an intratracheal tube and to give artificial respiration by bag for a period of several minutes. This flaccid paralysis was believed to be due to the use of curare.

When we found that the convulsive seizures could be controlled so readily by the use of curare, an attempt was made to set up a balanced system whereby the patient received a constant dosage sufficient to permit relaxation of muscles and aeration but not enough to cause respiratory paralysis. A continuous intravenous drip was started to provide adequate fluid intake. To each liter of fluid was added 10,000 units of tetanus antitoxin and up to 300 units of curare in the form of either *d*-tubocurarine chloride solution or intocostin[®] (E. R. Squibb & Sons). An insufficient quantity of *d*-tubocurarine was available for continuous use, and intocostin[®] was used interchangeably with it. It was necessary to give an occasional booster dose of curare intravenously or intramuscularly. We attempted to give slightly less than the amount required to keep the patient below the threshold of convulsions by the intravenous drip because of the danger of overdosage of curare and depended on close observation of the patient for the amount and timing of booster doses.⁵

After thirty-six hours of this management it was realized that a narrow zone existed between the flaccid respiratory paralysis caused by curare and the considerable respiratory embarrassment caused by the recurrent, extreme, tonic muscle spasm of the trunk characteristic of

5. The administration of the curare and the aspiration of secretions from the trachea and pharynx and artificial respiration were done by members of the department of anesthesiology when necessary, and especial credit for this patient's recovery must be given to Dr. Carl Johnson and Dr. Dorothy Darling, who alternated in constant attendance for the first seventy-two hours.

tetanus. In addition, the collection of viscid secretions in the respiratory passages added a mechanical obstacle to the free exchange of gases. Postural drainage of at least 25 degrees was difficult to maintain and relatively inefficient; aspiration with a catheter and a motor-driven suction apparatus frequently caused tonic convulsions which stopped respiration unless the patient was completely curarized. The use of atropine was tried, but if it had any effect on cutting down the quantity of secretions, it made them more stringy and sticky, so that the total effect was to make breathing more difficult. Moreover, the pulse became somewhat more rapid at times, and it was apparent that the patient was tiring and was obtaining insufficient gaseous exchange.

It was then reasoned, with subsequent justification in practice, that a tracheotomy and the use of a respirator would make possible the maintenance of a clear air passage and positive control of air exchange. With the tracheotomy, the thick secretion in the pharynx and larynx would be by-passed and the recurring laryngeal spasms would be of no consequence. It would also permit direct removal of the secretions in the trachea. The use of a respirator would make possible more latitude in the dose of curare. It was recognized that if a respirator were used without tracheotomy, secretion would be drawn into the lower airway and the pulmonary field. This could result in drowning the patient in her own secretions and produce atelectasis with secondary pneumonitis and sequelae, which have been so commonly found in patients dying of tetanus. It seemed, moreover, that when the patient was fully curarized the clinical picture was similar to that seen in cases of bulbosplinal paralysis, in which the use of the respirator proved effective after tracheotomy.

Once decided on, the procedure did not prove difficult. The patient was placed on the bed of the opened respirator in order to provide a quick change over after tracheotomy. The anesthetic tracheal rubber tube was in place, connected to the oxygen bag with which intermittent artificial respiration was being done by the anesthetist. The tube aided in fixing and raising the trachea. It was cut down on, an oval section of cartilage being removed from the third tracheal ring rather than at the usual lower level, so that it would lie above the respirator collar. A no. 4 tracheotomy tube was inserted, the wound packed and the oxygen tube quickly attached by a close-fitting rubber tube to the cannula.

When the patient's head was slid through the neck opening of the respirator collar, the respirator quickly closed, and the patient was immediately in good coordination with the machine. Her color improved, and the pulse slowed and became of good quality. It seemed much easier for her to rest and to sleep.

The rubber collar was satisfactorily held away from the tracheotomy tube by a soft "gray iron" bar $\frac{3}{8}$ (0.96 cm.) by $\frac{3}{4}$ inch (1.91 cm.) wide and 10 inches (25.4 cm.) long, bent at a suitable angle by a wrench and fixed under the steel flange around the collar.

The respirator was maintained in postural drainage of about 25 degrees and secretion aspirated through the tube when there was any sign of obstruction. Because a good mechanical humidifier was not available, there was some drying of secretion. Crusts and plugs were easily removed by aspiration after irrigation with several droppers of warmed 3 per cent solution of sodium bicarbonate followed by isotonic sodium chloride solution. At times the tube was removed and deeper aspiration made directly through the wound. The patient was well synchronized with the respirator when fully curarized. At levels at which some spasm or twitching was provoked by manipulation, the respirator was effective, although there then appeared to be ectopic respiratory efforts outside the regular cycle.

It is stated that prolonged curarization may produce a state similar to surgical shock and that the use of the drug must therefore be intermittent.⁶ The patient did at times have a rapid and irregular pulse, but there was no circulatory collapse. It was not easy to take her blood pressure when she was in the respirator, and this was not done.

It may be that the reason she did not show the picture of shock is that the amount of curare given via the continuous intravenous drip was not sufficient to produce complete flaccid paralysis. In fact, we attempted to err on the side of giving too little curare by this route, so that occasional booster doses were necessary. There was always greater than normal muscular tone; twitching and jumping of muscles could be observed at almost any time.

After ten days the dosage of curare was gradually diminished, and after twelve days it was discontinued. The use of the respirator was stopped for increasingly longer intervals. Even after the patient could breathe well voluntarily she was much more comfortable in the respirator for several days, or until she had regained her strength and had got back her normal respiratory habit.

Fluid and electrolyte balance, protein and vitamin needs were easily maintained by the intravenous route for the period of curarization. After the fifth day feeding by gavage was satisfactory through a no. 16 nasal catheter, which was kept closed when food was not being administered, in order to prevent indrawing of air. The respirator was left flat for one half hour after each feeding.

6. Cullen, S. C.: Curare, Its Past and Present, *Anesthesiology* 8:478-488 (Sept.) 1947. Adrian, J., and Ochsner, A.: Some Observations on the Use of Curare in the Treatment of Tetanus, *Surgery* 22:509-515 (Sept.) 1947. Curare in Clinical Medicine, E. R. Squibb and Sons, November 1948.

The dosage of curare was determined on the basis of the patient's reaction only. The largest amount given in any one twenty-four hour period was 1,500 units, and the total amount over a twelve day period was 11,750 units. The total number of units of tetanus antitoxin was 440,000. Administration of penicillin was continued throughout the period of treatment.

On the nineteenth day after the onset of symptoms the patient was up in a wheelchair, and on the twenty-third day all medication was discontinued.

Neurologic examination prior to the patient's discharge from the hospital showed an entirely normal condition, and there appeared to be no personality or intellectual change. An electrocardiogram was normal. The wound was nearly healed. Physical examination revealed no abnormalities.

SUMMARY

The combination of three measures—curare by continuous intravenous drip, tracheotomy and respirator—has been described in a severe case of tetanus and seemed to have these definite advantages:

1. It changed a hazardous treatment requiring unremitting care to a relatively simple, manageable, easily standardized procedure.
2. It allowed the use of curare in a latitude of dosage that is comparatively safe.
3. It guarded against dangerous periods of anoxia.
4. It by-passed secretions in the upper respiratory passage and permitted aspiration of secretions in the lower airway; it avoided atelectasis and secondary pulmonary infections due to obstruction.

ACUTE PANCREATITIS AND ITS SEQUELAE

THOMAS J. ANGLE, M.D.

AND

WILLIAM F. LEE Jr., M.D.

BROOKLINE, MASS.

THE TERM acute pancreatitis calls to the mind of most surgeons the relatively uncommon highly fatal acute hemorrhagic form of the disease. To Elman¹ must go much of the credit for pointing out the frequency with which the disease occurs in milder form and for emphasizing the necessity for routine determinations of serum amylase in all cases of pain in the upper abdominal area.

The clinical manifestations of the disease vary greatly. In acute hemorrhagic necrosis the attack is ushered in by the sudden onset of agonizing pain in the upper abdominal area, frequently radiating through to the back, accompanied with protracted nausea and vomiting. The patient is prostrated, the pulse weak and thready and examination reveals tenderness and spasm across the upper part of the abdomen. A sense of fulness in the epigastrium is frequently noted, or a mass consisting of the greatly swollen pancreas may be felt. A peculiar grayish cyanosis is sometimes observed.

From this extreme, symptoms of all gradations of severity are seen, and in cases of the acute edematous or acute interstitial form of the disease, as Elman² has pointed out, there may be no distinguishing characteristics and the disease may mimic any of the other causes of severe pain in the upper abdominal area such as cholecystitis, perforated ulcer, intestinal obstruction or coronary thrombosis. The diagnosis is established in these cases by the demonstration of an elevation of the serum amylase level.

Despite extensive experimental and clinical study, there remains wide divergence of opinion regarding the cause of acute pancreatitis. Most observers comment, however, on the frequent association of chronic disease of the gallbladder.

1. Elman, R.: *Surgical Aspects of Acute Pancreatitis with Special Reference to Its Frequency as Revealed by Serum Amylase: Max Bellin Lecture*, J. A. M. A. **118**:1265-1268 (April 11) 1942.

2. Elman, R.: *Nitroglycerine in the Treatment of Acute Pancreatitis*, Am. J. Digest. Dis. **6**:474-475 (Sept.) 1939.

Of the various hypotheses which have been put forward to explain its origin, those which have gained widest acceptance are as follows: first, the reflux of bile into the pancreatic duct resulting from conversion of the common bile duct and the pancreatic ducts into a common channel by obstruction at the ampulla of Vater, by a calculus, from spasm of the sphincter of Oddi or from edema; second, obstruction of the pancreatic ducts by cysts or tumors or by epithelial metaplasia as described by Rich and Duff.³ Other etiologic factors frequently mentioned are trauma, occlusion of the arterial or venous circulation of the pancreas by thrombosis or embolism and infection, lymph or blood borne, extending from adjacent organs or ascending the duct from the duodenum or the biliary tract.

Whatever the initiating cause, there seems to be substantial agreement that the subsequent changes which occur in the pancreas are related to the release of tryptic activity of the pancreatic proteolytic enzyme. The manner in which the inactive proenzyme trypsinogen becomes activated remains unsettled.

The pathologic changes which occur in acute pancreatitis vary, with the severity of the disease, from a diffuse edema of the organ and adjacent structures in the acute interstitial form to the most extensive destruction. In acute hemorrhagic necrosis the pancreas is converted into a tense, swollen, darkly mottled organ with areas of hemorrhage and necrosis of varying extent. There may be areas of suppuration, and in extreme cases the entire gland may be gangrenous. Areas of fat necrosis may be widespread over the parietal peritoneum and omentum or localized in the region of the foramen of Winslow. Varying amounts of consommé-like or hemorrhagic fluid are found in the free peritoneal cavity and in the lesser peritoneal sac.

It is to be expected that such extensive changes in the parenchyma of the pancreas will lead, in a certain percentage of nonfatal cases, to secondary sequelae after the acute process has subsided.

In the suppurative form of the disease, with extensive destruction of pancreatic tissue, localization of the process and abscess formation are likely to occur.

When extensive destruction of pancreatic tissue has occurred and when infection does not play a dominant role, conditions are set up which may give rise to the later development of so-called pseudocysts.

Pinkham⁴ stated that pseudocysts may be formed within the substance of the pancreas as the result of degenerative changes affect-

3. Rich, A. R., and Duff, G. L.: Experimental and Pathological Studies on Pathogenesis of Acute Hemorrhagic Pancreatitis, *Bull. Johns Hopkins Hosp.* 58:212-259 (March) 1936.

4. Pinkham, R. D.: Pancreatic Collections (Pseudocysts) Following Pancreatitis and Pancreatic Necrosis: Review and Analysis of Ten Cases, *Surg., Gynec. & Obst.* 80:225-235 (March) 1945.

ing the interstitial tissues of the gland or adjacent to the pancreas when the corrosive action of the pancreatic ferments has led to encapsulated accumulations about the gland.

As in subdiaphragmatic abscess or any other inflammatory disturbance beneath the diaphragm, it would appear likely that an inflammatory process in the pancreas might occasionally result in the production of a pleural effusion in the adjacent thoracic cavity. This finding has been infrequently reported, but such cases have been described by Metheny⁵ and Hultén.⁶

It has been suggested by Peterson and Cole⁷ that acute edematous pancreatitis may lead to the later development of chronic fibrosing diffuse pancreatitis. They report 3 such cases.

In a series of 20 cases of acute pancreatitis, of which 12 were classified as acute edematous and 8 as acute hemorrhagic pancreatitis, all the aforementioned sequelae have been observed. Four cases are briefly reported:

CASE 1.—A woman of 68 was seized by a severe pain in the upper abdominal area associated with protracted nausea and vomiting. Examination showed generalized abdominal tenderness, most pronounced in the epigastrium and the left upper quadrant. The white blood cell count was 17,000 and the temperature 101.5 F. A clinical diagnosis of acute pancreatitis was made and later confirmed by the presence of a serum amylase level of 1,217 units. A roentgenogram of the abdomen showed gallstones. She was treated conservatively with supportive measures and sodium sulfadiazine and penicillin. Her course was stormy, but her general condition slowly improved. She continued to have a febrile course, however, and three weeks after admission a roentgenogram of the chest revealed pleural effusion on the left side. A subdiaphragmatic abscess on the left was suspected. A roentgenogram made after a barium enema and an intravenous pyelogram gave indication of a mass displacing the splenic flexure downward and distorting the upper pole of the left kidney. The left anterior subdiaphragmatic space was explored extraperitoneally, and nothing was found. The peritoneum was opened, and a large abscess of the pancreas was found. This was marsupialized, and almost 2 quarts (2,000 cc.) of thick yellow pus was evacuated. The patient's condition improved, but the pleural effusion increased and in the ensuing six weeks thoracentesis was done on the left side six times, with removal each time of from 700 to 1,500 cc. of hemorrhagic fluid. The cultures were sterile on all occasions. The fluid reaccumulated rapidly. The drainage from the abscess gradually diminished, her general condition improved and she was discharged nine weeks after admission with persistent pleural effusion. This slowly absorbed over a period of many months, and she finally made a full recovery and has recently been reported well.

5. Metheny, D.: Personal communication to the authors.

6. Hultén, O.: Beitrag zur Röntgendiagnose der abutend Pankreasaffektionen, *Acta radiol.* 9:222-254, 1928.

7. Peterson, L. W., and Cole, W. H.: Chronic Sclerosing Pancreatitis Causing Complete Stenosis of Common Bile Duct, *Arch. Surg.* 51:15-21 (July) 1945.

CASE 2.—A woman of 35 was admitted to the hospital three days after the onset of severe pain in the left upper abdominal area associated with persistent nausea and vomiting. Examination showed tenderness and spasm in the left upper quadrant, and just to the left of the umbilicus a firm tender mass the size of an egg was felt. She was operated on after a preoperative diagnosis of incarcerated internal hernia. Acute hemorrhagic pancreatitis was present. The mass was found to consist of matted adherent omentum. An ileostomy was done and a drain placed down to the pancreas. The patient's course was a stormy one, but she gradually improved until one month later, when a constant dull ache in the lumbar area developed. Several days later a mass was palpated high in the left upper quadrant. This rapidly increased in size. A series of roentgenograms of the upper gastrointestinal tract showed the stomach displaced downward and forward. At operation a large pancreatic pseudocyst was found containing cloudy blood-tinged fluid. This was marsupialized, and she made a complete recovery.

CASE 3.—A man aged 37 with a previous history of repeated attacks of severe midabdominal pain over a period of years was admitted to the hospital after the sudden onset of agonizing generalized abdominal pain associated with persistent nausea and vomiting. Examination showed generalized abdominal tenderness, most apparent in the left upper quadrant. The white blood cell count was 19,800, and the blood sugar content was 250 mg. per hundred cubic centimeters. A diagnosis of acute pancreatitis was made, and he was treated conservatively, recovered and was discharged, with advice to return for cholecystectomy.

Sixteen months later he returned with a complaint of nausea and vomiting and a constant dull ache in the upper part of the abdomen, with intermittent attacks of sharper pain. Two weeks later cholecystectomy was done. This showed chronic cholecystitis without stones.

Seven months later, two years after the initial attack, he returned, complaining of dull nonradiating pain in the left upper quadrant. Examination revealed a mass the size of a grapefruit in the left upper quadrant. A diagnosis of pseudocyst of the pancreas was made, and at operation this was confirmed. Approximately 2 quarts (2,000 cc.) of dark brown turbid fluid was evacuated. His convalescence was satisfactory until three weeks after the operation, when he had a severe hemorrhage from the draining sinus. In the next four days he had repeated severe hemorrhages, which were not controllable by packing of the cavity, and he died despite repeated transfusions. It was felt that the hemorrhage had resulted from erosion of a vessel by the corrosive action of pancreatic proteolytic enzyme.

CASE 4.—A man aged 32 was awakened on the morning of his admission to the hospital by a sudden severe pain in the right upper quadrant radiating across the midline to the left. This became progressively worse, and two hours later he vomited. Examination showed tenderness and spasm across the upper part of the abdomen, most pronounced on the right. He presented a peculiar grayish cyanosis. A diagnosis of acute pancreatitis was made, and he was operated on. The gallbladder was tense and thickened. The entire pancreas was swollen and somewhat thickened, and there was considerable edema of the adjacent posterior parietal peritoneum, and small droplets and rivulets of fluid could be seen beneath it. There were similar droplets of fluid beneath the pancreatic capsule. There was no fat necrosis. A diagnosis of acute edematous pancreatitis was made, and cholecystectomy was done.

He remained well until two years later, when he began having recurring attacks of distress and distention in the upper abdominal area, at times with nausea and vomiting. These attacks came about once or twice a month and continued on and off until two years later, when he was readmitted to the hospital with deep jaundice. A diagnosis of obstruction of the common duct due to pancreatitis was made, and he was operated on. The gallbladder was distended but contained no stones. The entire pancreas was thickened and fibrotic. These changes were most notable in the head. The common duct was opened, and a uterine sound was passed into the duodenum with the greatest difficulty. The instrument was gripped firmly in the intrapancreatic portion of the duct. Nothing larger could be passed. The duodenum was opened, and a catheter was fastened to the uterine sound and pulled up through the duct. A tapered vitallium® tube was then fastened to the catheter and pulled down through the duct. The gallbladder was then removed and the duct drained. He made an excellent recovery from the operation, and the jaundice cleared up and has not recurred, but he has continued to have periodic attacks of epigastric distress. Ten months later he was readmitted to the hospital for study of his pancreatic secretions. The trypsin, diastase and lipase concentrations were all diminished but were well above the levels seen in cases of achylia pancreatica. It was felt, however, in view of the findings at operation and of these findings that this represented a case of chronic fibrosing pancreatitis resulting from a previous acute edematous pancreatitis.

SUMMARY

Significant surgical sequelae were observed five times in 4 cases among 20 patients suffering an attack of acute pancreatitis. These consisted of residual abscess formation, pseudocyst and chronic pancreatitis producing biliary obstruction.

1180 Beacon Street (Dr. Anglem).

PATHOGENESIS OF POSTOPERATIVE PULMONARY ATELECTASIS

An Experimental Study

RANDOLPH T. SHIELDS Jr., M.D.
BLACK MOUNTAIN, N. C.

ONE OF the most discouraging complications confronting a surgeon is the clinical entity commonly called postoperative pulmonary atelectasis. By postoperative atelectasis reference is made to that pulmonary complication which occurs within the first two or three postoperative days. This condition is accompanied with actual obstruction within the bronchial tree. The classic signs and symptoms of this condition include fever, leukocytosis, cough, purulent or tenacious sputum and an area in the lung of dullness to percussion and of diminished or absent breath sounds. The classic roentgenographic findings include diminution in lung volume, displacement of the mediastinum and narrowing of the overlying intercostal spaces.

Postoperative atelectasis should be differentiated from postoperative pneumonia, which may give rise to the same symptoms and even the same physical signs, before actual consolidation occurs. Clinically, a roentgenogram of the chest taken in expiration may differentiate the two conditions.¹ However, there are undoubtedly many combinations of these two conditions, such as pneumonitis behind an obstruction and an obstruction superimposed on a previously existing pneumonia.

It may be questioned whether the familiar postoperative complication should properly be called atelectasis. By strict definition, atelectasis means imperfect expansion, though clinically the term is commonly used to include collapsed pulmonary tissue. Certainly, collapsed pulmonary tissue is at least a part of so-called postoperative pulmonary atelectasis. If clinical atelectasis consists in collapsed pulmonary tissue alone, it is difficult to understand why it should give rise to fever, leukocytosis, cough and sputum. If simple collapse of pulmonary tissue causes such

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From the Department of Surgery, University of Utah School of Medicine, Salt Lake City.

1. "In a true atelectasis, displacement toward the side of the lesion is present on expiration as well as on inspiration, while in consolidation this displacement is present on inspiration only" (Holmes, cited by King, D. S.: Surg., Gynec. & Obst. 56:43, 1933.

symptoms, why do not such symptoms occur in patients with therapeutic pneumothorax? It would seem logical to conclude that the symptoms of postoperative atelectasis are due, rather, to pneumonitis, pneumonia or suppuration which exists peripheral to the point of obstruction. On the other hand, if such an infectious process exists beyond the obstruction, it is difficult to understand why the process is so rapidly and dramatically relieved by removal of the obstructing factor.

Lamar and Meltzer² concluded that the occlusion of air passages is an aid in the production of experimental lobar pneumonia, and Coryllos and Birnbaum³ even expressed the opinion that the obstruction of air passages is an essential factor in the production of lobar pneumonia. Coryllos and Birnbaum⁴ also stated that atelectasis might predispose to an infectious process in the parenchyma of the lung by localization of organisms from the circulating blood.

It is felt that obstruction of the air passages may predispose the lung to infection but that atelectasis per se does not do so. The concept of the misuse of the term atelectasis was obtained from Dr. J. Burns Amberson,⁵ who wrote:

I think the diagnosis of atelectasis in the specific sense is usually erroneous, because as a rule there is little or no collapse of the alveoli, but, rather, an accumulation of edema fluid, which is often soon followed by pneumonia. . . . The important concept, which is fundamental, is that collapse of the alveoli in itself does not predispose to pneumonia, whereas edema always does.

Gunn⁶ also stated the belief that edema fluid predisposes to pneumonia.

Coryllos⁷ pointed out the close relation of the postoperative pulmonary complications usually described as postoperative bronchitis, atelectasis and pneumonia, and he expressed the opinion that generally these conditions follow one another in the order named, without clear-cut, distinctive signs and symptoms. Undoubtedly, there are combinations of pulmonary complications. The purpose of the present study was to determine the part played by obstruction.

In the presence of bronchitis existing prior to obstruction of a bronchus, one would expect the occurrence of secretions and organisms

2. Lamar, R. V., and Meltzer, S. J.: Experimental Pneumonia by Intra-bronchial Insufflation, *J. Exper. Med.* **15**:133, 1912.

3. Coryllos, P. N., and Birnbaum, G. L.: Lobar Pneumonia: Considered as Pneumococcic Lobar Atelectasis of the Lung; Bronchoscopic Investigation, *Arch. Surg.* **18**:190 (Jan., pt. 2) 1929.

4. Coryllos, P. N., and Birnbaum, G. L.: Obstructive Massive Atelectasis of the Lung, *Arch. Surg.* **16**:501 (Feb.) 1928.

5. Amberson, J. B.: Personal communication to the author.

6. Gunn, F. D.: Pathogenesis of Pneumonia, *M. Clin. North America* **32**:9 1938.

7. Coryllos, P. N.: Postoperative Pulmonary Complications and Bronchial Obstruction, *Surg., Gynec. & Obst.* **50**:795, 1930.

beyond the point of obstruction, and it would seem probable that such a condition is favorable to the development of an infection within the involved lung. However, bronchial obstruction alone, causing a dry atelectasis, is presumably not harmful in itself. Adams and Livingstone,⁸ as well as Allen,⁹ showed that pulmonary suppuration is not associated with bronchial obstruction alone as produced experimentally in dogs.

What proof is there that bronchial obstruction will aid in the production of pulmonary infection and in increasing its severity? The answer to this question varies somewhat with the organisms involved. Allen⁹



Fig. 1.—Roentgenogram of the chest of a dog in expiration, two days after ligation of the main bronchus to the middle lobe of the right lung.

showed that obstruction of the bronchus, producing a collapse of pulmonary tissue, plays a prominent part in the formation of experimental aspiratory anaerobic abscesses of the lung. On the other hand, Adams and Vorwald¹⁰ showed that obstruction of the bronchus, with the

8. Adams, W. E., and Livingstone, H. M.: Obstructive Pulmonary Atelectasis. *Arch. Surg.* 23:500 (Sept.) 1931.

9. Allen, D. S.: Etiology of Abscess of the Lung, *Arch. Surg.* 16:179 (Jan., pt. 2) 1928.

10. Adams, W. E., and Vorwald, A. J.: The Treatment of Pulmonary Tuberculosis by Bronchial Occlusion, *J. Thoracic Surg.* 3:633, 1934.

resulting collapse of pulmonary tissue, actually enhances the healing of tuberculous (aerobic) infections. It would seem that ventilation aids the growth of aerobic organisms and lack of ventilation favors the growth of anaerobic organisms.¹¹

Whether or not atelectatic pulmonary tissue is a site of predilection for certain organisms circulating in the blood stream has been considered. In a small series of dogs, Adams¹² found that septic and aseptic emboli containing lead pellets were twice as likely to lodge in atelectatic as in inflated pulmonary tissue, whereas tuberculous (aerobic) emboli were much less likely to lodge in atelectatic than in inflated pulmonary tissue.

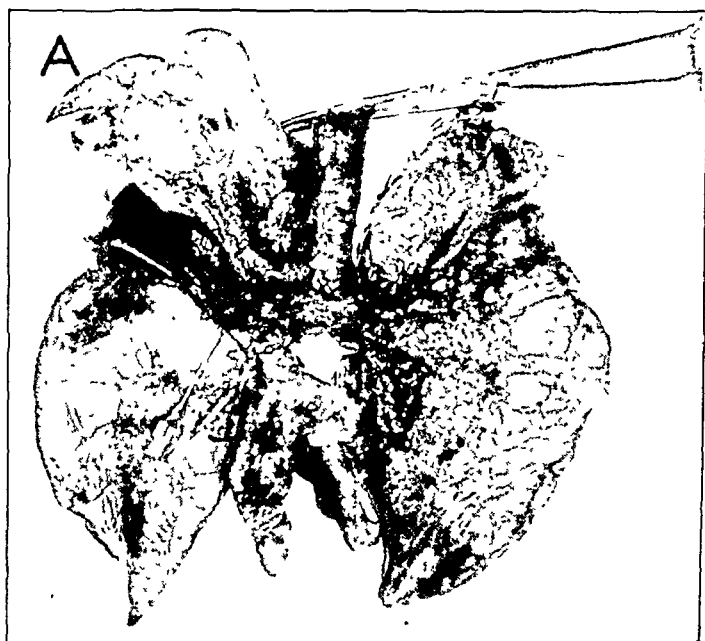


Fig. 2 (group 1).—A, ligation of the main bronchus of the middle lobe of the right lung two days before the dog was killed. The needle points to the site of ligature.

PROCEDURE

The following experiment on dogs was an attempt to throw light on the part played by bronchial obstruction in postoperative pulmonary complications. Obstruction of the bronchus was produced by ligation of the bronchus with a soft, strong cotton string. Proof of the complete occlusion was evident in the

11. Coryllos, P. N.: How Do Rest and Collapse Treatment Cure Pulmonary Tuberculosis? *J. A. M. A.* **100**:480 (Feb. 18) 1933.

12. Adams, W. E.: Rapid Healing of Embolic Lung Abscess in Atelectatic Lobes, *Proc. Soc. Exper. Biol. & Med.* **29**:539, 1931.

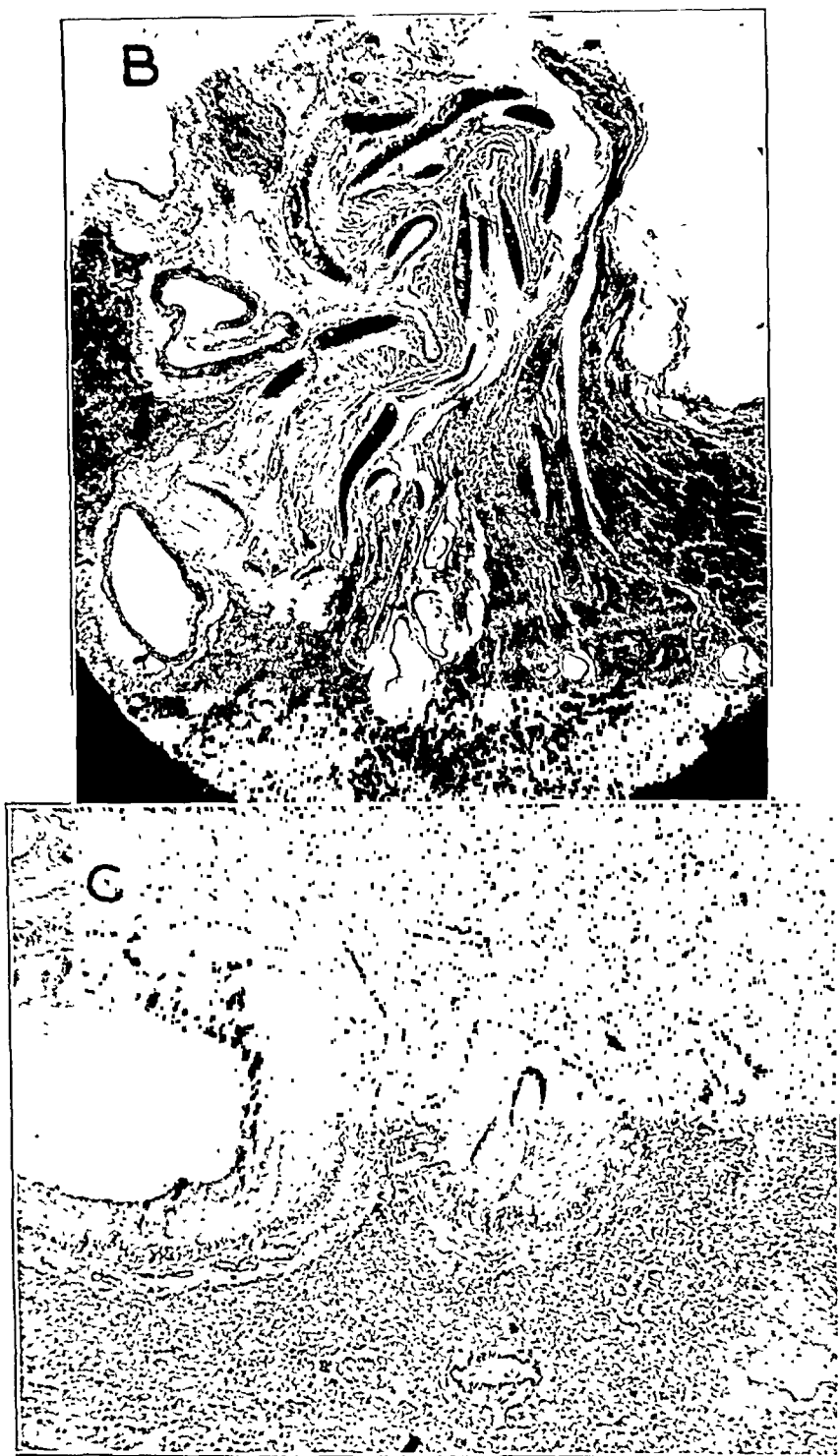


Fig. 2.—*B*, section taken at the site of ligation of bronchus, showing inflammatory reaction and area of necrosis due to ligation with atelectasis. *C*, ligation of the bronchus, with accumulation of mucus within the bronchioles and atelectasis.

inability to pass injected water through the obstructed bronchus. The obstruction was observed by a microscopic section taken at the level of the ligature. The bronchus of the middle lobe of the right lung was selected because of its anatomic accessibility. Routine anesthesia induced by intravenous injection of 5 per cent pentobarbital sodium U. S. P. (2.7 cc. per pound, 6 cc. per kilogram, of body weight) was used. The chest was entered through the right fifth interspace. An artificial respirator, constructed from an electric fan motor and connected to an air pressure system, supplied alternating pressure through an intratracheal tube. This device gave satisfactory aeration.

A virulent organism to which dogs were susceptible was used. A type I pneumococcus, designated as A5/8D 102R, was obtained from Dr. O. H. Robertson, and its virulence was maintained according to his specifications.¹³ This pneumococcus grew better on the surface than it did in the depths of stab inoculations of rabbit serum agar, although it did grow in the depths also. Septicemia was produced in 2 normal dogs by intravenous injections of 1 and 3 cc., respectively, of broth culture. Pneumococci were recovered from the heart blood or from the splenic pulp at autopsy. No gross evidence of involvement of the lungs was noted.

The introduction of sterile gastric mucin with the pneumococcus was considered, since mucin has been known to increase the likelihood of producing experimental pneumonia,¹⁴ but this substance was not used, as it was deemed wiser to avoid the introduction of more factors than was necessary.

Four groups of dogs were used, in order that the factor of obstruction might be evaluated.

Group 1.—The main bronchus of the middle lobe of the right lung was ligated.

Group 2.—The pneumococcus culture, 0.25 cc., was injected into the bronchus of the right middle lobe by means of a curved hypodermic needle passed through the wall of the bronchus in a manner causing the injected medium to pass toward the periphery of the lobe.

Group 3.—The bronchus was both ligated and injections made into it in a manner identical to that described in groups 1 and 2, the injections being given peripheral to the ligature.

Group 4.—The dogs were subjected to ligation of the bronchus of the middle lobe of the right lung. This procedure was followed, either immediately or several days later, by the intravenous injection of the pneumococcus culture. The lower lobe of the right lung was traumatized in order that the factor of manipulative trauma might be evaluated. No evidence of any effect of such trauma was noted.

These dogs were followed clinically and killed on the first, second or third day after treatment, or occasionally later. On a number of dogs preoperative

13. The pneumococci were kept in a stock culture of heart infusion broth (Difco) to which was added 2 per cent whole rabbit blood. In growing it for use, two or three loopfuls were planted into serum-dextrose broth (heart infusion broth plus 2 per cent serum, either rabbit or horse, and 0.5 per cent dextrose). To keep up its virulence, the organism was passed through a rabbit every six weeks. (Dr. O. H. Robertson, in a personal communication to the author.)

14. Nungester, W. J., and Jourdonais, L. F.: Mucin as an Aid in the Experimental Production of Lobar Pneumonia, *J. Infect. Dis.* 59:258, 1936.



Fig. 3—*A* (dog from group 2), injection of pneumococcus into the middle bronchus of the middle lobe of the right lung one day before the dog was killed. The arrow points to the site of injection. *B*, lung of a normal dog.

and postoperative rectal temperatures and white blood cell counts were determined. In a number of dogs preoperative and postoperative roentgenograms were taken of the chest.

The temperature and white blood cell values were recorded. Rectal temperatures in all four groups showed no significant changes except for the 2

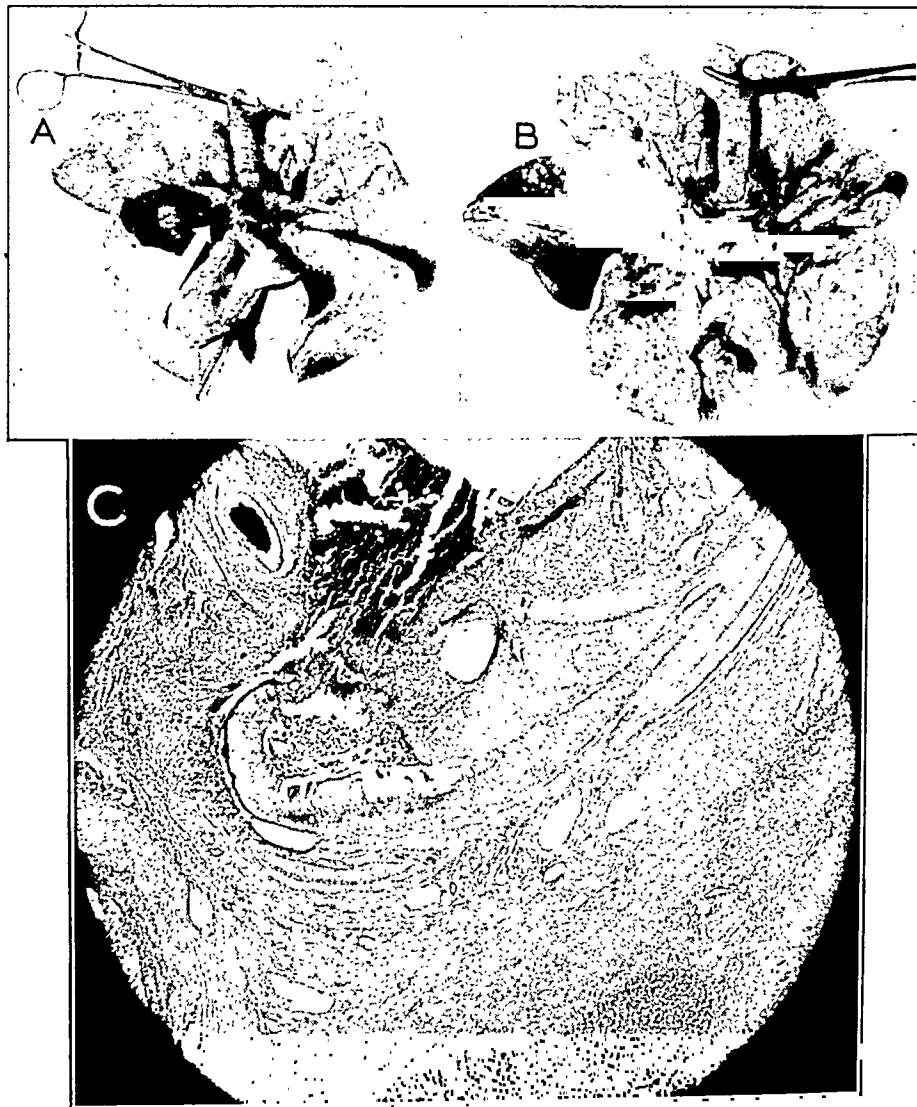


Fig. 4 (group 3).—*A*, ligation and injection of the main bronchus of the middle lobe of the right lung one day before the animal was killed. The arrow points to the site of the ligature. *B*, ligation and injection of the main bronchus of the middle lobe of the right lung three days before the dog was killed. *C*, ligation and injection of bronchus, showing purulent bronchitis and peribronchitis, with necrosis of the bronchial wall, and atelectasis with scanty leukocytic infiltration.

acutely ill, dying dogs, whose temperatures were increased over 3 degrees (F.), and a third dog, whose temperature dropped 3 degrees (F.) just before death.

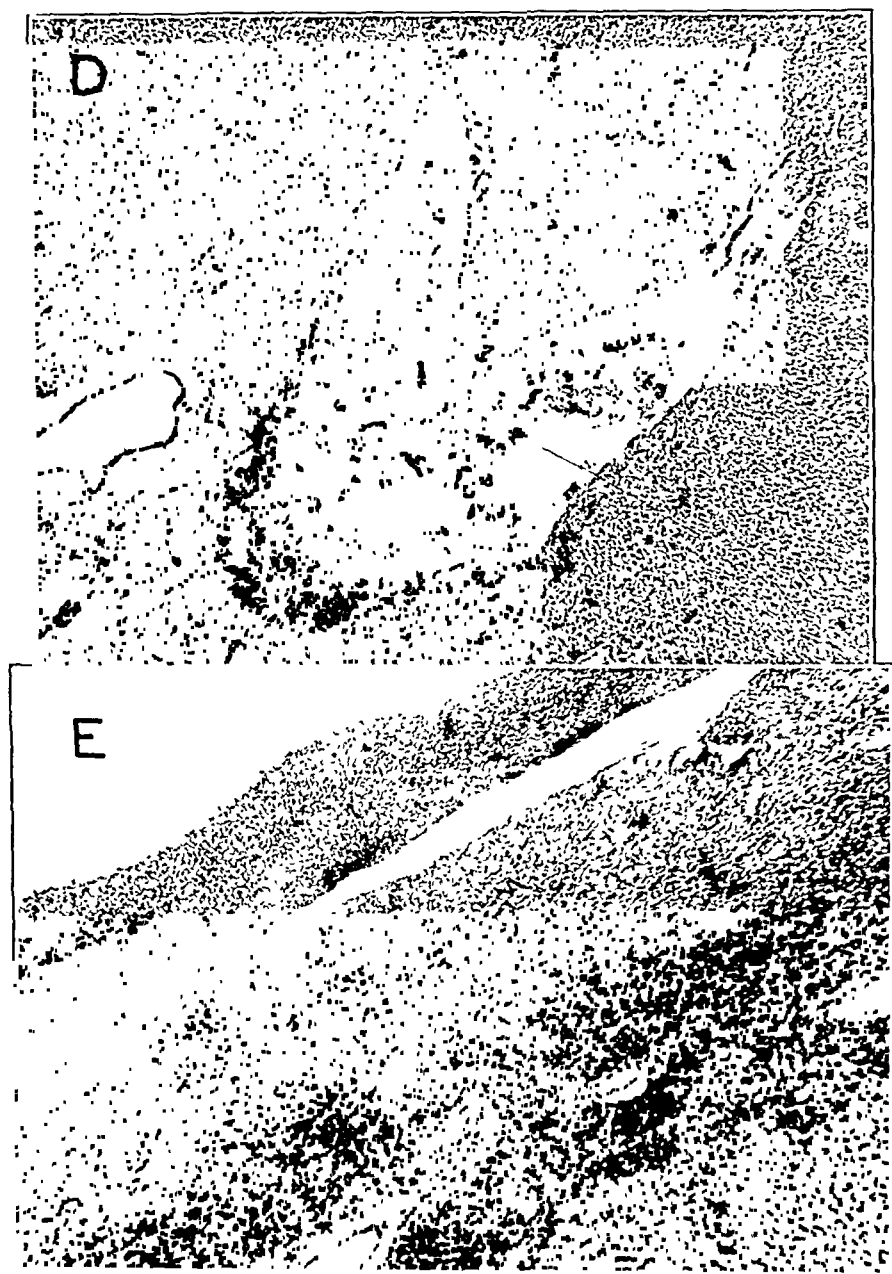


Fig. 4.—*D*, ligation and injection of bronchus and showing bronchiolitis, with desquamation of the bronchiolar epithelium into the lumen, pneumonia. *E*, ligation and injection of bronchus, with fibrinocellular exudate on the pleural surface, atelectasis and pneumonia.

The thoracotomies seemed to have no appreciable effect on the temperature reactions of these dogs. The white cell counts showed changes in either direction after various procedures. In most instances there was some leukocytosis following thoracotomy with or without ligation of a bronchus. After the intravenous injection of the pneumococci culture leukocytosis was usually noted. Two of the acutely ill dogs had pronounced leukopenia. No attempt was made to determine the heart rate in these dogs, and none showed evidence of coughing. It would seem that the dog does not lend itself to a clinical comparison with man, at least not so far as temperature, white blood cell counts and cough are concerned.

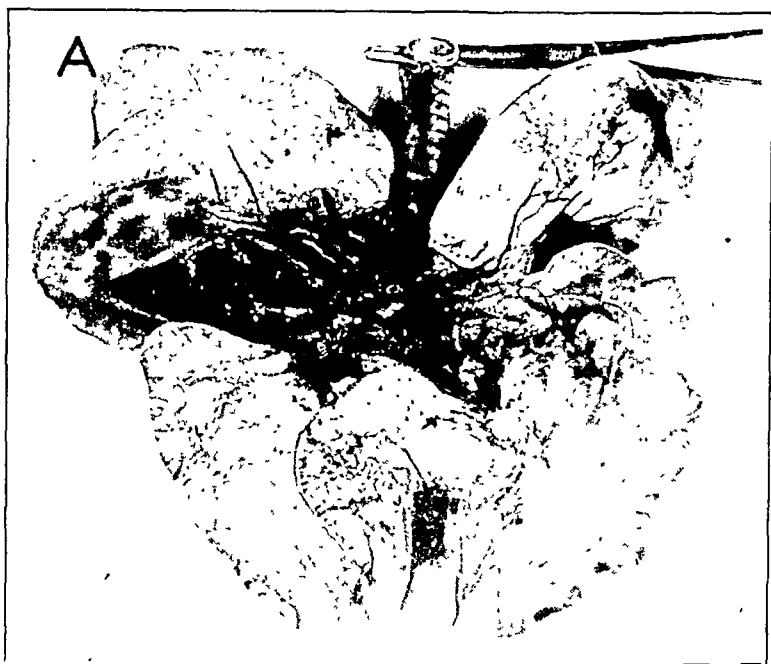


Fig. 5 (group 4).—*A*, ligation of bronchus eleven days, and intravenous injection three days, before the dog was killed. Note the small nodular elevations of the pleural surface.

RESULTS

A number of roentgenograms were taken of the dogs' chests, and variations were noted in the four groups. Atelectasis was evident in group 1. Group 2 showed no demonstrable changes. A number of dogs in group 3 showed evidence of consolidation. The picture in group 4 showed no definite changes toward consolidation and appeared to be similar to the atelectatic picture seen in the dogs of group 1.

The results in each group were followed by tabulating the type and weight of each dog, the postoperative course, the postoperative day on which the dog was killed and the autopsy observations, gross and microscopic, of the lobes that were obstructed or had received



Fig. 5.—Effect of ligation of the bronchus and intravenous injection showing (B) bronchiolitis with purulent exudate, peribronchiolitis and bronchopneumonia with leukocytic exudate in the alveoli, and (C) fibrinous pleuritis, with red blood cells and neutrophils within the fibrin, and bronchopneumonia in the atelectatic lung.

injections and of those that were not obstructed or had not received injections.

GROUP 1.—The ligation of the main bronchus to the middle lobe of the right lung alone did not affect the immediate health of the dogs, and the pathologic changes were simply those of atelectasis. The accumulation of mucus within the lumen of the bronchi and bronchioli was noted beyond the point of obstruction. Acute inflammatory exudate in the bronchial lumen and pleuritis were not in only 1 of the 6 dogs.

GROUP 2.—The intrabronchial injection of pneumococci produced no appreciable signs of disease, and in only 1 of 6 dogs was pneumonia produced. Why the pneumonia occurred in this dog, and not in the others, is a matter of conjecture. The presence of bronchial obstruction was not demonstrated. Perhaps the resistance of the particular host was not great enough to overcome the virulence of the pneumococci. No pleuritis was noted in any of the lobes.

GROUP 3.—The dogs in which the bronchus of the middle lobe of the right lung was both ligated and given direct injections of pneumococci all showed leukocytic infiltration of the parenchyma and pleuritis. Two of the lobes not having bronchial obstruction or pneumococcic injection showed areas of focal leukocytic infiltration, but otherwise seemed normal.

GROUP 4.—The bronchus of the middle lobe of the right lung was ligated and immediately or subsequently thereafter an intravenous injection of the pneumococcus culture was given. Bronchopneumonia developed in the collapsed lobe in 1 of these 7 dogs. Purulent exudate in the bronchi of the collapsed lobes was noted in all 7 dogs of this group. Of the nonobstructed lobes of these 7 dogs there was an area of slight focal leukocytic infiltration in 1 and an area of bronchopneumonia in another. Four of the 7 collapsed lobes showed definite pleuritis, while no involvement of the pleura could be demonstrated in the aerated pulmonary tissue except for an interlobar empyema on the surface of a collapsed portion of a lobe adherent to a ligated lobe.

COMMENT

These observations more than suggest that the obstructed lobes have a greatly increased susceptibility to the pneumococcus when the organism is introduced directly into the bronchial lumen of the ligated lobe. This susceptibility would seem to be due to the trapping of the organisms within the obstructed lobe. The presence of accumulated mucus may enhance the growth of the trapped organisms,¹⁴ and the lack of drainage prevents the expulsion of the organisms. Poor ventilation does not seem to be the responsible factor, since this organism

grows better in the presence than in the absence of air. It would seem likely that the uniform pleural involvement was secondary to the enclosed pneumonitis.

The intravenous injection of pneumococci in mice is known to produce pneumonia,¹⁵ but the results have rarely been obtained in other experimental animals. Kempf and Nungester¹⁶ produced pneumonia in rats after using intrabronchial inoculation of sterile mucin, followed by the intravenous injection of pneumococci. They concluded that "the presence of mucous material in the lung or some comparable condition is a necessary predisposing factor for the localization of the pneumococci."¹⁷

In the fourth group of dogs the susceptibility to infection of the ligated lobe from the blood stream seemed definitely greater than that of the aerated lobes. This ratio is further increased by the fact that there are six aerated lobes to each obstructed lobe. The pleura was involved more often than was the lung parenchyma. In this group of dogs there was no trapping of organisms within a "bottled-up" lobe, as was the case in the third group. Is it not possible that the presence of mucus, accumulated behind the obstruction, is the initiating cause of the increased susceptibility to the pneumococcus?³ Such a postulate would seem likely in the development of infections in the bronchial tree and alveoli, as well as in the pleura, which presumably becomes involved by extension from the lung parenchyma. Trauma to the surface of the lobe during the operative procedure is apparently not the factor producing the pleuritis, since trauma of like or greater severity was applied to the adjacent lower lobe of the right lung without producing pleuritis.

The lack of drainage of both mucus and organisms is doubtless an aid to the continuation of infection behind an obstruction, whether the organism is introduced intrabronchially or intravenously.¹⁷

Although the evidence may be presumptive, it seems that the most likely cause of the increased susceptibility to pneumococcic infection of the ligated lobes was the increased mucus content of those lobes. Such a postulate is in accord with the work of Kempf and Nungester¹⁶ and others,¹⁸ who noted the greatly increased susceptibility of rats to pneu-

15. Rake, G.: Pathogenesis of *Pneumococcus* Infection in Mice, *J. Exper. Med.* **63**:191, 1936.

16. Kempf, A. H., and Nungester, W. J.: Production of Pneumonia in Rats by Intravenous Injection of *Pneumococci*, *Proc. Soc. Exper. Biol. & Med.* **43**:627, 1940.

17. Coryllos and Birnbaum.³ Nungester, W. J., and Klepser, R. G.: A Possible Mechanism of Lowered Resistance to Pneumonia, *J. Infect. Dis.* **63**:94, 1938.

18. Robertson, O. H.; Coggeshall, L. T., and Terrell, E. E.: Experimental *Pneumococcus* Lobar Pneumonia in the Dog, *J. Clin. Investigation* **12**:433, 1933.

mococci introduced intrabronchially and intravenously when sterile gastric mucin was instilled into the bronchial tree.

This experiment has not included any therapeutic measures, but the evidence in favor of the assumption that excess intrabronchial mucus is a detrimental factor is further substantiated by the clinical relief obtained by the removal of bronchial plugs and bronchial mucus in cases of postoperative pulmonary atelectasis.

In a further study of the importance of mucous contents in the bronchial tree of the atelectatic lung, it would be interesting to compare the respective amounts of mucus in pulmonary lobes collapsed by compression, as in pneumothorax, in lobes collapsed by bronchial obstruction. Would the nonobstructed lobes reveal less mucus, owing to partial, if not complete, drainage? If such were to prove the case, would there be any demonstrable difference in the susceptibility of the two types of collapsed lobes to pneumococcic infection?

Mucus may not be the only factor producing this enhancement of effective virulence of certain organisms. The fluids produced by such factors as congestive heart failure, trauma and irritants may well play a part in the increased susceptibility of pulmonary tissue to infectious organisms. However, mucus is ever present and would seem to be the substance most usually causing this increased susceptibility in persons previously possessing normally functioning lungs.

It would seem that the condition commonly referred to as postoperative pulmonary atelectasis is not merely bronchial obstruction with subsequent atelectasis. In most instances postoperative pulmonary atelectasis is initiated by bronchial obstruction, which, in turn, produces a certain amount of alveolar collapse but also leads to the accumulation of mucus. The mucus, in turn, may aid in the localization and prevent the dispersion of certain organisms, including the pneumococcus. The infection thus produced is presumably the cause of such symptoms as leukocytosis and fever, rather than the obstruction and alveolar collapse per se. Removal of the obstruction not only permits the inflation of alveoli but allows the evacuation of mucus, and it is probably the riddance of the accumulated mucus and the associated organisms which permits the patient to recover. It is logical that the earlier the mucus is evacuated the more rapid will be the recovery. Such a belief is substantiated by clinical therapeutic results.¹⁹

SUMMARY AND CONCLUSIONS

Experiments were carried out on four groups of dogs:

In the first group the ligation of the main bronchus of the middle lobe of the right lung produced atelectasis of this lobe and the accumu-

19. Schmidt, H. W.; Mousler, L. H., and Harrington, S. W.: Postoperative Atelectasis, *J. A. M. A.* **120**:895 (Nov. 21) 1942.

lation of mucus within the ligated bronchial tree. No appreciable detrimental effect on an otherwise normal dog was produced by this procedure. In the second group, a type I pneumococcus was injected into the lumen of the main bronchus of the middle lobe of the right lung, and in 5 of the 6 dogs no infection of the lobe was noted. In the third group, ligation of the main bronchus of the middle lobe of the right lung was accompanied with the intrabronchial injection of pneumococci peripheral to the point of obstruction. In all 7 dogs the collapsed lobes showed evidence of bronchitis, leukocytic infiltration of the parenchyma and pleuritis. In the fourth group, ligation of the bronchus of the middle lobe of the right lung was followed by the intravenous injection of pneumococci. The obstructed lobes were more susceptible to infection than were the nonobstructed lobes. Purulent bronchitis was the common finding, and 4 of the 7 dogs revealed pleuritis of the ligated lobes.

The following conclusions were formed as a result of this study: Obstructive atelectasis and pulmonary infection in dogs do not seem to give rise to the classic symptoms found in man, such as elevations of temperature, leukocytosis and cough.

The pulmonary changes in dogs have produced roentgenograms analogous to those found in man.

The factor in the production of infection in postoperative pulmonary atelectasis seems to be the accumulation of mucus in the bronchial tree, rather than the collapse of pulmonary tissue.

Black Mountain, N. C. (P. O. Box. 913).

NONSUTURE METHOD FOR VASCULAR ANASTOMOSIS UTILIZING THE MURPHY BUTTON PRINCIPLE

HARRY H. LeVEEN, M.D.

NEW YORK

IN 1900 Payr¹ introduced a nonsuture method of anastomosis employing a magnesium tube. One cut end of the vessel was drawn through the tube and everted over its edge, the intimal surface thus being brought to the outside. The vessel was held in this position by a ligature. The other opened cut end of the vessel was then drawn over the tube and secured again by ligature. The forceful electrochemical activity brought about by the presence of magnesium in tissues produced widespread necrosis.² Such anastomoses were, therefore, doomed to failure. More recently, Lord, Blakemore and Stefko³ have introduced a vitallium[®] tube which is used in the same way as the original Payr tube but has the advantage of being made of a metal which does not produce tissue reaction. By use of this tube, these authors have advanced the scope of vascular surgery.⁴ Their method, however, has technical disadvantages, making its use much more difficult than one might suppose. It is not well adaptable to deep abdominal surgery because of difficulty in placing ties and slippage of knots incident to tying on a rigid metal structure.

A method of anastomosis is herein suggested employing the non-suture technic and utilizing a rigid tube⁵ of teflon[®] plastic, which sub-

From the Department of Surgery, New York University School of Medicine.

1. Payr, E.: *Beiträge zur Technik der Blutgefäss, und Nervennaht nebst Mittheilungen über Verwendung eines resorbirbaren Metales in der Chirurgie*, Arch. f. klin. Chir. **62:67**, 1900.

2. Venable, C. S., and Stuck, W. G.: *A General Consideration of Metals for Buried Appliances in Surgery*, Surg., Gynec. & Obst. **76:297**, 1943.

3. Blakemore, A. H.; Lord, J. W., and Stefko, P. L.: *Restoration of Blood Flow in Damaged Vessels*, Ann. Surg. **117:481**, 1943.

4. Blakemore, A. H., and Lord, J. W.: *The Technique of Using Vitallium Tubes in Establishing Portal Caval Shunts for Portal Hypertension*, Ann. Surg. **122:476**, 1945.

5. The entire device is available from the Zack Manufacturing Company, Berwyn, Ill.

stance has been found nonabsorbable and free of tissue reaction.⁶ The original work was done with nylon,⁶ but this substance produced some tissue reaction which did not occur with teflon.⁶ The principle involved is somewhat similar to the Murphy button principle and allows for satisfactory anastomosis with maximum ease and rapidity.

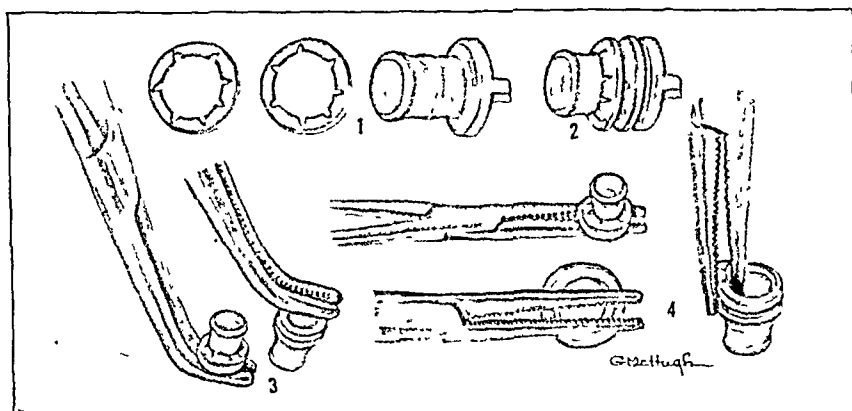


Fig. 1.—Component parts of the device for anastomosis and suggested methods of holding the tube to secure maximum stability.

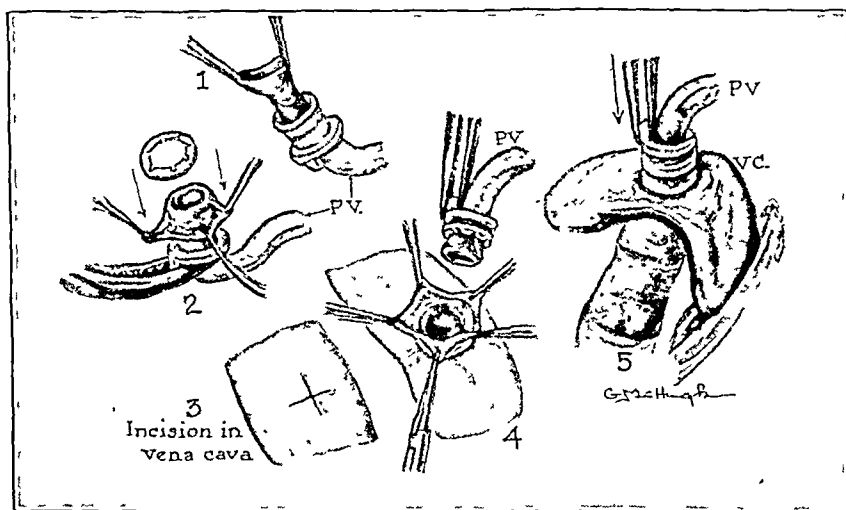


Fig. 2.—The various steps in the portal caval shunt operation. After ligation and division of the portal vein (*P.V.*) the cut end (occluded by a bulldog clamp) is pulled through an anastomosis tube and secured (1 and 2). A cruciate incision is made in the occluded vena cava (3). The cut edges of the incision are drawn through the anastomosis ring (4). With a finger placed beneath the vena cava for support, the prepared portal vein is pushed through the ring (4) to complete the anastomosis (5).

6. LeVeen, H. H., and Barberio, J. R.: Tissue Reaction to Plastics Used in Surgery with Special Reference to Teflon, *Ann. Surg.* **129**:74, 1949.

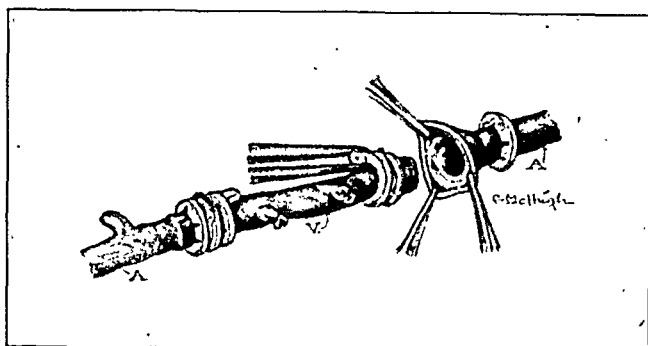


Fig. 3.—A method by which end to end arterial anastomosis could be performed.

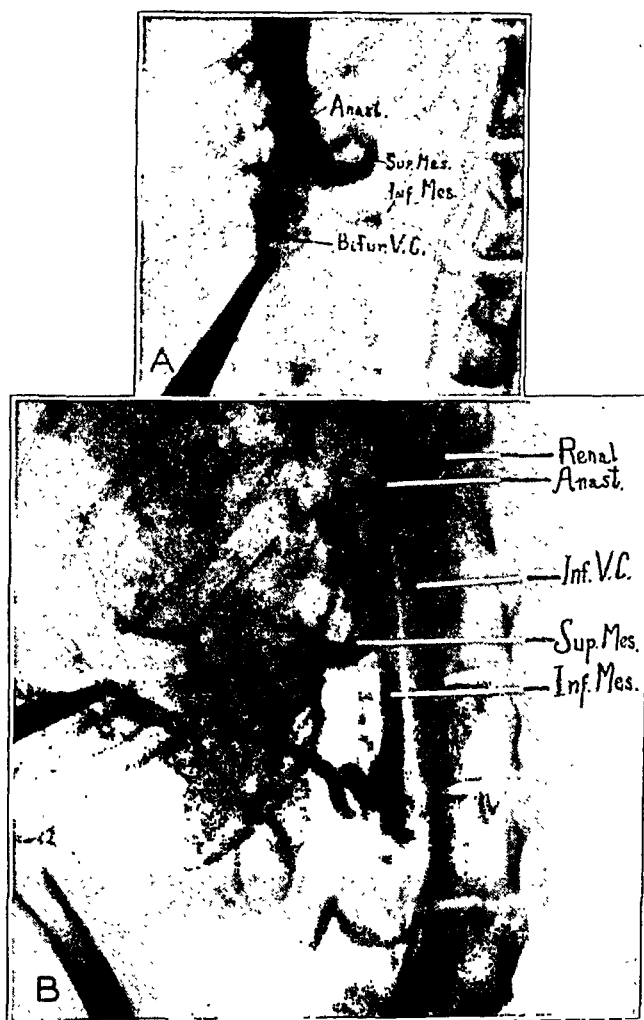


Fig. 4.—The venograms were made by injecting a small venule in the mesentery of the small bowel with 70 per cent diodrast®. The free flow into the vena cava is demonstrated. Both venograms were taken six weeks after portal caval shunt. *A*, dog 281; *B*, dog 342.

DESCRIPTION OF METHOD

The apparatus for anastomosis is illustrated in figure 1. It consists of two scalloped nylon® rings and a teflon® tube. The rings slip over the free ends of the tube as illustrated and are secured by the spring action of their scalloped edges as well as by the small ridges on the outer surface of the tube. A small projection from the basal rim serves as a handle for holding and manipulating the tube. The entire device is sterilized by boiling.

End to Side Anastomosis.—This procedure is illustrated by an Eck fistula operation (portal caval shunt) performed on dogs.

After adequate exposure has been obtained (a Z, T or L-shaped incision is used) the inferior vena cava is freed for a distance of 2 inches (5.08 cm.) in the region where the anastomosis is to be performed. This is usually about an inch



Fig. 5.—Photograph of a gross specimen removed at autopsy. The vena cava has been opened to show the patent portal anastomosis. This specimen was removed six weeks postoperatively. The small amount of perivascular fibrosis seen here does not occur with teflon® tubes.

(2.54 cm.) above the entrance of renal veins. After the vena cava has been freed, it should be possible to introduce the index finger beneath it with ease.

The portal vein is then isolated to the point where it is formed by the junction of the superior and inferior mesenteric veins. A Dieffenbach clamp is placed on it at this juncture. Ligation and division of the portal vein is performed just below the splenic vein. If it is desired to shunt the splenic circulation as well, ligation and division should be performed immediately beneath the bifurcation of the portal vein into the right and left hepatic veins. The vena cava is then clamped above and below the point of anastomosis with nontraumatic clamps.

The exact details of this anastomosis are illustrated in figure 2. Extreme care should be exercised in the selection of the size of the tube. It is important to prevent excessive tension and traction on the vein lest the thin-walled vessel be

torn or frayed. The diameter of the tube should be 1 mm. smaller than the diameter of the portal vein. If one is to err, it is better to err on the side of smallness. The opened end of the prepared portal vein should be moistened with heparin in isotonic sodium chloride solution. It would also seem advisable to administer heparin postoperatively.⁷

End to End Anastomosis.—End to end anastomosis may be satisfactorily performed as is illustrated in figure 3. This type of anastomosis is most suited to arterial work, with which the author has had no experience. The use of any nonsuture device for arterial anastomosis seems ill advised for reasons to be mentioned later.



Fig. 6.—Photomicrographs of healed anastomosis showing absence of foreign body reaction. Healing is complete, and the exact area of joining is no longer discernible.

RESULTS OF SURGICAL PROCEDURES ON DOGS

An Eck fistula was performed in 20 dogs. Of 8 dogs which died in the first forty-eight hours, in none was the death attributable to blockage of the portal vein. Almost all the dogs in this group were found to have distemper, with pneumonic consolidation. Among the 12 that survived more than forty-eight hours, death from portal thrombosis occurred after three days in only 1 dog. The remainder of the dogs

7. Murray, G.: Heparin in Surgical Treatment of Blood Vessels, *Arch. Surg.* 40:307 (Feb.) 1940.

were killed after periods ranging from ten days to four months after operation for postmortem examination. Among the last 10 dogs operated on there was only 1 death, which was caused by distemper. In almost all the dogs the intimal surface of the portal vein was moistened with heparin and isotonic sodium chloride solution. Some dogs were given a small injection of heparin postoperatively.

The patency of the anastomoses was adequately illustrated by venograms taken at the time of autopsy (fig. 4). Autopsies on all dogs surviving more than forty-eight hours (with the exception of the one in which thrombosis occurred at the site of anastomosis) showed well healed areas of intima to intima anastomosis (fig. 5). There was no evidence of tissue reaction except for a few adhesions at the operative site, which are explainable on the basis of trauma at the time of operation or possibly of talc from the rubber glove (fig. 6).

COMMENT AND CONCLUSIONS

The need for speed in some forms of vascular surgery is imperative. In portal caval shunt operations, occlusion of the portal vein for a period of more than thirty minutes is hazardous since it may produce fatal shock in normal dogs or human beings. The method of anastomosis which has been described is rapid and simple. The results of anastomosis compare favorably with other methods.

It has some limitations, however, common to methods employing the use of rigid tubes.⁸ A percentage of large arteries undergo necrosis at the site of contact of the artery with the rigid tube and rupture. In the case of the aorta, rupture may be produced by any circular structure placed around it and contacting the adventitia.⁹ For this reason it probably would be best not to attempt the anastomosis of large arteries by the nonsuture method, although its use with small and medium-sized vessels would seem justified. For arterial anastomosis, a different type of locking ring must be used to avoid uniform circumferential pressure on the adventitia and to allow enough clearance for the relatively thicker arterial wall.

As yet no human being has been treated by this method although its extreme simplicity and favorable results as compared with other methods would warrant its use.

8. Murray, G., and Janes, J. N.: The Healing of Arteries and the Relationship to Hemorrhage, *Surgery* **18**:624, 1945.

9. Pearse, H. E.: Experimental Studies on the Gradual Occlusion of Large Arteries, *Ann. Surg.* **112**:923, 1940.

SUMMARY

A simplified method for performance of vascular anastomosis has been described. The method adapts the Murphy button principle to small plastic tubes.

The results of the method which was employed in dogs are discussed and analyzed.

Mr. William Zack, of the Zack Manufacturing Company, designed the anastomosis tubes.

LYMPHOSARCOMA OF THE DUODENUM

Report of a Case; Review of the Literature

MURRAY M. COPELAND, M.D.*

Professor of Oncology, Georgetown University Medical Center
WASHINGTON, D. C.

AND

D. JAMES GREINER, M.D.

Chief of Pathological Service, Kennedy Veterans Hospital
MEMPHIS, TENN.

THE LITERATURE on lymphosarcoma of the duodenum, the jejunum and the intestinal tract in general is replete with numerous comprehensive surveys, in addition to reports of small groups of cases emphasizing various diagnostic problems and findings.¹ Much of the material is valueless for statistical purposes because of the chaotic state of the nomenclature, inadequate reporting and poor follow-up observations on the patients.

From the Kennedy Veterans Hospital.

Presented at the Southern Surgeons Club, Atlanta, Ga., May 19 to 20, 1947.

*Dr. Copeland was formerly Chief of Surgery at the Kennedy Veterans Hospital at Memphis.

Published with permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the authors.

1. (a) Assman, H.: Die klinische Roentgendiagnostik der inneren Erkrankungen, Leipzig, F. C. W. Vogel, 1930. (b) Beer, E.: Lymphosarcoma of the Small Intestine, S. Clin. North America 5:93-96, 1925. (c) Berman, H., and Mainella, F.: Lymphosarcoma of Small Intestine, Am. J. Surg. 70:121-125, 1945. (d) Benjamin, E. L., and Christopher, F.: Primary Lymphosarcoma of the Small Intestine, Am. J. Clin. Path. 10:408-413, 1940. (e) Borden, D. L., and Taylor, F. D.: Primary Lymphosarcoma of Small Intestine: Case, Mil. Surgeon 92: 255-257, 1943. (f) Callender, G. R.: Tumors and Tumor-Like Conditions of the Lymphocyte, the Myelocyte, the Erythrocyte and the Reticulum Cell, Am. J. Path. 10:443-466, 1934. (g) Cave, H. W.: Tumors of the Small Intestine, Ann. Surg. 96:269-285, 1932. (h) Charache, H.: Primary Lymphosarcoma of Intestine, Am. J. Surg. 27:171-173, 1935; (i) Primary Lymphosarcoma in Boy of Seven: Follow-Up of Nine Years, *ibid.* 59:601, 1943. (j) Cheever, D.: Clinical Aspects and Treatment of Primary Lymphosarcoma of the Stomach and Intestines, Ann. Surg. 96:911-923, 1932. (k) Chont, L. K.: Sarcomas of Small Intestine and Reference to Their Radiosensitivity, Radiology 36:86-97, 1941. (l) Cohn, S.; Landy, J. A., and Richter, M.: Tumors of Small Intestine, Arch. Surg. 39: 647-666 (Oct.) 1939. (m) Crowther, C.: Studio dei sarcome primitive dell'intestino tenue con contributo di tre casi originale, Clin. chir., Milano 21:2107-2144,

(Footnote continued on next page)

Ewing,¹⁸ in a classic statement on "General Pathology of Lymphosarcomas" summed up the matter as follows:

. . . A search for statistical data brings to light the notable fact that there are no reliable data on this subject and also that in the present state of knowledge and the attitude of the medical public mind, there is no possibility of obtaining them From this state of affairs, one obtains support for the impression that lymphosarcoma, although a major medical problem, is a badly neglected field of observation, and that until some efforts are made to bring order into this chaos, beginning with nomenclature, little accurate information regarding the economic and social significance of this disease will be available. All we know is that lymphosarcoma is a relatively common disease, nearly always fatal, of quite obscure etiology and pathology, generally difficult of diagnosis, and little influenced by treatment. All these facts were well known to Paltauf and Kundrat fifty years ago.

Despite this state of affairs, it seems worth while to continue the reporting of interesting cases in detail which have adequate pathologic study, especially those in which unusual complications occur.

1913. (n) Cutler, G. D.; Stark, R. B., and Scott, H. W., Jr.: Lymphosarcoma of the Bowel in Childhood, *New England J. Med.* **232**:665-670, 1945. (o) Davies, E.: Lymphosarcoma with Perforation of Gastric and Intestinal New Growth, *Brit. M. J.* **2**:64-65, 1937. (p) Desjardins, A. U., and Ford, F. A.: Hodgkin's Disease and Lymphosarcoma, *J. A. M. A.* **81**:925 (Sept. 15) 1923. (q) Dinsmore, R. S., and Ancona, V. C.: Reticulum Cell Sarcoma of the Jejunum: Case Report, *Cleveland Clin. Quart.* **11**:77-79, 1944. (r) Doub, H. P., and Jones, H. C.: Primary Malignant Tumors of Small Intestines, *Radiology* **26**:209-220, 1936. (s) Ewing, J.: General Pathology of Lymphosarcoma, *Bull. New York Acad. Med.* **15**:92-103, 1939. (t) Forgue, E., and Chauvin, E.: Le cancer primitif et intrinsèque du duodénum, *Rev. de chir.* **49**:470-472, 1914-1915. (u) Frank, L. W.; Miller, A. J., and Bell, J. C.: Sarcoma of Small Intestine: Four Cases, *Ann. Surg.* **115**:544-565, 1942. (v) Fraser, K.: Malignant Tumors of the Small Intestine: Review of the Literature and Report of Twenty-One Cases, *Brit. J. Surg.* **32**:479-491, 1945. (w) Gall, E. H., and Mallory, T. B.: Malignant Lymphoma: Clinico-Pathological Survey of Six Hundred and Eighteen Cases, *Am. J. Path.* **18**:381-429, 1942. (x) Geschickter, C. F.: Tumors of the Digestive Tract, *Am. J. Cancer* **25**:130-161, 1935. (y) Goldstein, H. I.: Primary Sarcoma of Intestines: A Review of Recorded Cases, *Am. J. Surg.* **35**:240, 1921. (z) Graves, S.: Primary Lymphoblastoma of the Intestine: Plea for Logical Classification of Tumors, *J. M. Research* **40**:415-431, 1919. (a') Greenfield, H.: Early Roentgen Diagnosis of Jejunal Lymphosarcoma: Report of Case, *Am. J. Roentgenol.* **36**:674-677, 1936. (b') Holmes, G. W.; Dresser, R., and Camp, J. D.: Lymphoblastoma: Its Gastric Manifestations with Special Reference to the Roentgen Findings, *Radiology* **7**:44-50, 1926. (c') Hulbert: Specimen of Sarcoma of Viscera, *St. Louis M. & S. J.* **48**:250-252, 1885. (d') Jackson, A. S.: Lymphosarcoma of Jejunum, *Wisconsin M. J.* **37**:478-480, 1938. (e') Kasemeyer, E.: Intussusception of the Intestines, *Deutsche Ztschr. f. Chir.* **118**:205-207, 1912. (f') Kelley, T. H.: Lymphosarcoma of the Small Intestine, *J. A. M. A.* **82**:785-787 (March 8) 1924. (g') Kundrat, H.: Ueber Lympho-Sarkomatosis, *Wien. klin. Wchnschr.* **6**:211-234, 1893. (h') Lewis, D. L.: Two Cases of Sarcoma of Small Intestine with Unusual Features: Leiomyosarcoma of Ileum;

The following report is that of a patient who had a duodenal lesion with large aneurysmal dilatation, marked stenosis of the duodenojejunal angle and evidence of perforation at the site of the tumor.

REPORT OF CASE

G. H., a white man aged 26, was admitted to Kennedy Veterans Hospital on Sept. 6, 1946, with the complaint of recurrent attacks of diffuse abdominal distention, edema of the ankles and vomiting.

History.—The history of the family was noncontributory. The patient stated that he had been entirely well until three years prior to entering the Army. At that time, there developed periumbilical pain, which usually came on about three hours after he had eaten or when the weather was hot. The pain was relieved by his taking milk and alkalis and was aggravated or precipitated by his eating fatty or fried foods. One year previously, in September 1945, while he was in the Army, the patient vomited dark brown blood for three or four days and passed bright red blood by rectum. He was hospitalized in an Army hospital, where he received blood transfusions. He had a severe reaction from the blood transfusions and was told that he had a high titer of cold hemagglutinins. The diagnosis of peptic ulcer was made, without roentgenographic demonstration. He was returned to duty after several months in the hospital.

Lymphosarcoma of Small Intestine with Perforation, *Brit. J. Surg.* **26**:540-546, 1939. (*i'*) Libman, E.: Sarcoma of the Small Intestine, *Am. J. M. Sc.* **120**:309-327, 1900; (*j'*) Malignant Lymphoma (Stem-Cell Type) of Jejunum, Cabot Case 26041, *New England J. Med.* **222**:149-152, 1940; (*k'*) Multiple Lymphosarcoma of Jejunum and Ileum, Cabot Case 28242, *ibid.* **226**:959-960, 1942. (*l'*) Mayo, C. W., and Robins, C. R., Jr.: Lymphosarcoma, *S. Clin. North America* **15**:1163-1170, 1935. (*m'*) McSwain, B., and Beal, J. M.: Lymphosarcoma of Gastrointestinal Tract: Twenty Cases, *Ann. Surg.* **119**:108-123, 1944. (*n'*) Menne, F. R.; Mason, D. G., and Johnston, R.: Lymphosarcoma of the Intestine: Two Cases, *Arch. Surg.* **45**:945-956 (Dec.) 1942. (*o'*) Minot, G. R., and Isaacs, R.: Lymphoblastoma (Malignant Lymphoma): Age and Sex Incidence, and Effect of Roentgen Ray and Radium Irradiation and Surgery, *J. A. M. A.* **86**:1185-1189 (April 17); 1265-1270 (April 24) 1926. (*p'*) Moreton, R. D.: Lymphosarcoma with Primary Manifestations in the Gastrointestinal Tract: Seven Cases Studied Roentgenologically, *Texas State J. Med.* **41**:458-464, 1946. (*q'*) Morrison, J. E.: Tumors of Small Intestine, *Brit. J. Surg.* **29**:139-153, 1941. (*r'*) Morrison, W. A., and Donath, D.: Tumors of the Small Intestine, *California & West. Med.* **55**:235-237, 1941. (*s'*) Nickerson, D. A., and Williams, R. H.: Malignant Tumors of Small Intestine, *Am. J. Path.* **13**:53-64, 1937. (*t'*) Nothnagel, H., and Rolleston, H. D.: Diseases of the Intestines and Peritoneum, translated by A. Stengel, Philadelphia, W. B. Saunders Company, 1905, pp. 443-451. (*u'*) Oettle, E.: Primary Sarcoma of Small Intestine as Cause of Perforating Peritonitis, *Deutsche Ztschr. f. Chir.* **245**:75-79, 1935. (*v'*) Pattison, A. C.: Malignant Lymphoma of the Gastrointestinal Tract, *Arch. Surg.* **29**:907-922 (Dec.) 1934. (*w'*) Pissarewa, T.: Lymphogranulomatosis of the Digestive Tract, *Arch. f. klin. Chir.* **149**:75-91, 1927. (*x'*) Premoli, F.: Peritonitis from Perforation of Sarcoma, *Rev. méd. de Rosario* **21**:458-461, 1931. (*y'*) Present, A. J.: Primary Lymphosarcoma of Duodenum, *Am. J. Roentgenol.* **41**:545-548, 1939. (*z'*) Prey, D.; Foster, J. M., Jr., and Dennis, W.: Primary Sarcoma of Duodenum, *Arch. Surg.* **30**:675-684 (April) 1935. (*a''*) Ragins, A. B., and Shively, F. L., Jr.:

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Although he had been placed on a dietary regimen, he continued to have occasional attacks of pain. He was discharged from the Army in December 1945, with a diagnosis of peptic ulcer. In May 1946, because of severe vomiting, pain and weakness, he was forced to give up his job of driving the local school bus. In July he noted, for the first time, swelling of the ankles and bloating of the abdomen. Because of the abdominal discomfort, he put himself on a diet consisting of little else but milk; this he consumed in large quantities. He continued to vomit occasionally. The vomitus contained partially digested food but no blood. At the beginning of the period of abdominal distention, he was having one or two bowel movements daily, and for two weeks thereafter he continued to have them. He had never had diarrhea or constipation. On the day of admission to Kennedy Hospital, he had one large bowel movement. About August 1 he had his first fainting spell, which was followed by several others. After the third attack, at his family's insistence, he entered another hospital, on August 19. At that hospital, a Miller-Abbott tube was inserted, and the patient was given fluids, including amigen® (a hydrolysate of casein prepared by digestion with sheep and hog pancreas), plasma and dextrose. He was given penicillin intramuscularly. Two days after his admission, a flat roentgenogram of the abdomen showed gas throughout the entire gastrointestinal tract. The chest was said to be normal. The impression at that time was that of incom-

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plete obstruction of the small intestine. After a barium sulfate enema, fluoroscopic examination showed that the colon was normal but that the small bowel was distended with gas. On September 3, about two and one-half weeks later, another flat roentgenogram of the abdomen showed that the Miller-Abbott tube was coiled in the stomach, with considerable gastric secretion remaining in the stomach. The roentgenographic changes were thought to be consistent with a diagnosis of obstructing duodenal ulcer and paralytic ileus. The patient then was referred to Kennedy Veterans Hospital for definitive treatment.



Fig. 1.—Roentgenogram of abdominal cavity with patient in the anterior and upright position. Note the air-containing cavity and the fluid level. The fluid content was made up of partially digested food, which shows as a mottled opaque shadow beneath the fluid level

Physical Examination.—The patient was observed to be somewhat cachectic and noticeably dehydrated, with extreme pallor. He was lying quietly in bed, in no apparent pain. The temperature was 98.6 F, the pulse rate 92, the respiratory rate 24 and the blood pressure 88 systolic and 55 diastolic.

Head: No tenderness was observed. The pupils reacted actively and equally to light and in accommodation. No aural tenderness or discharge was noted. There was no nasal obstruction. The mucous membranes of the oral cavity were dry, but otherwise normal.

Neck: No abnormalities were observed.

Lymph Nodes: No lymph nodes were palpable in the neck, the axillas or the epitrochlear or inguinal regions.

Chest: No tenderness was noted; expansion was limited but equal bilaterally. There was no impairment of resonance and no rales. The heart did appear enlarged on percussion; the sounds were of good quality; rhythm was normal, and there were no murmurs.

Abdomen: The abdomen was soft; it was noticeably distended, without tenderness; no unusual peristalsis was seen. Auscultation disclosed occasional



Fig. 2.—Roentgenogram of the lateral view of the abdomen taken in the upright position, showing that the Miller-Abbott tube lies in the duodenum and has not entered the aneurysmal dilatation containing air and fluid. The entire small intestinal tract is displaced against the posterior abdominal wall.

borborygmi and splash in the right lower quadrant and the umbilical region, especially in the former site. The abdomen was hyperresonant, with tympany anteriorly. There was equivocal shifting dullness. No masses were felt; the liver and spleen were not palpable.

Rectum: Examination revealed nothing abnormal. The patient had a Miller-Abbott tube in place, but there was no drainage at the time of examination.

Clinical Impression—The tentative diagnosis was subacute perforation of a peptic ulcer with subacute obstruction of the small intestine. The patient was too ill to be examined further.

Laboratory Findings (Sept. 6, 1946).—The hemogram showed 3,100,000 red cells and 7,600 white cells per cubic millimeter, with 91 per cent polymorphonuclear cells. The hemoglobin concentration was 55 per cent (Sahli). The serologic reactions were negative. Total proteins measured, 62 mg; albumin, 3.9 mg.; globulin, 2.3 mg.; (albumin-globulin ratio, 1.7); nonprotein nitrogen, 33 mg, and chlorides, 610 mg per hundred cubic centimeters



Fig. 3—Gross specimen of the diseased portion of the terminal duodenum. Site A shows the orifice of the less diseased portion of the duodenum as it enters the cavity. Note the large lumen of the orifice. Site B reveals the orifice of the efferent portion of the bowel, which is distinctly stenosed. The stenosed area is located at the beginning of the jejunum.

Urinalysis showed a specific gravity of 1.021, a trace of albumin, innumerable hyaline casts and some granular casts.

Roentgenographic Examination.—Both sides of the diaphragm were in high position. A small air bubble was present in the fundus of the stomach. No air was shown immediately below the diaphragmatic domes. There was a slight

pleural thickening in the lower left side of the chest. No significant pathologic condition was present in the lungs.

Abdomen: A huge, walled-off cavity was present in the anterosuperior portion of the abdomen. It measured about 26 cm. in width, 23 cm. in length and 16 cm. in depth. Approximately one half was filled with fluid, with a freely shifting level. The mottled appearance of the fluid shadow was due to intermingling of the fluid with gas bubbles, and possibly to the presence of fibrin. A huge gas bubble was present above the fluid level. The roof of this cavity was at the level of the twelfth dorsal to the first lumbar vertebra. It was sealed off from the subdiaphragmatic area, probably by adherent omentum. The stomach was pressed against the posterior abdominal wall. It contained only a

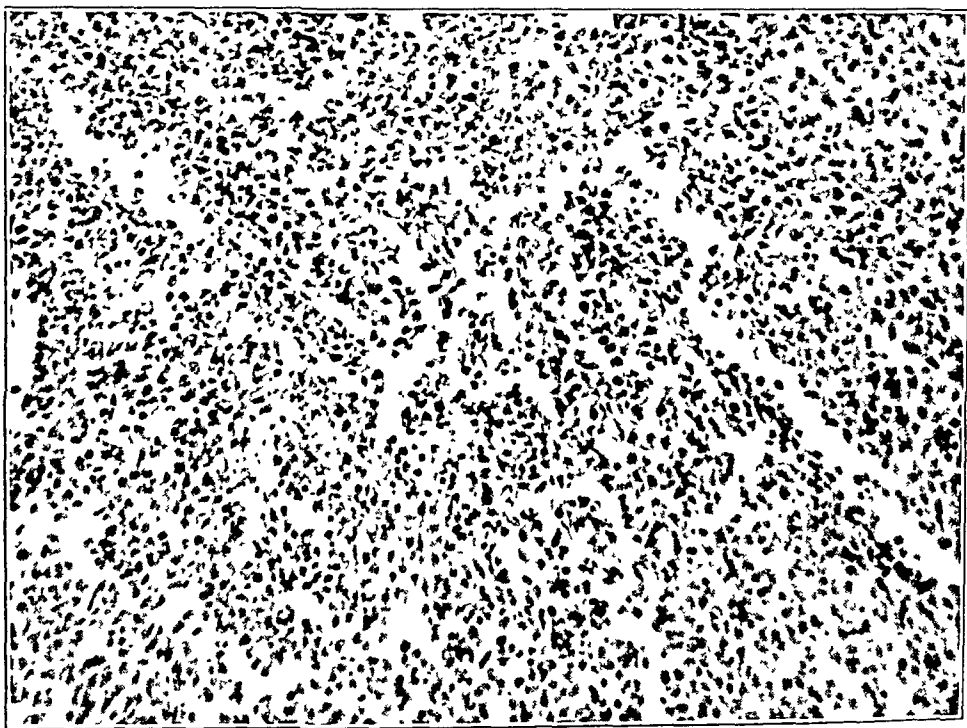


Fig. 4.—Photomicrograph of section of the tumor revealing cells of the reticular type embedded in a fine reticular stroma. The diagnosis was reticulum cell lymphosarcoma.

small gas bubble and the figure-of-eight loop of a Miller-Abbott tube, of which the terminal end extended through the pylorus and the duodenum to the vicinity of the ligament of Treitz. The entire tract of the small intestine was displaced against the posterior abdominal wall. No appreciable amount of air was contained in it, and its location could be established only by small scattered droplets of mercury coming from the first bulb of the Abbott tube. The cecum and the lower portion of the descending colon were in normal position, while the transverse colon and the flexures were displaced posteriorly. The colon was outlined by gas content, which was within normal limits. A few gas-capped, small fluid levels were present in the lower and upper abdominal areas, on the

right side, most of them situated in the colon. Intestinal stasis and distention, if present at all, appeared to be slight (figs. 1 and 2).

Opinion.—The diagnosis was that of a huge intra-abdominal abscess, containing fluid and gas, which was extravisceral, as described.

Operation.—On the morning following the patient's admission, September 7, operation was performed. When the abdominal wall was opened through an incision in the upper part of the right rectus muscle, the peritoneum was observed to be densely adherent to a mass which was unidentifiable but seemed cystic. After much difficulty, a survey of the stomach and the first part of the duodenum revealed no pathologic changes. The liver and gallbladder were normal. The right kidney was normal. The transverse colon was not involved

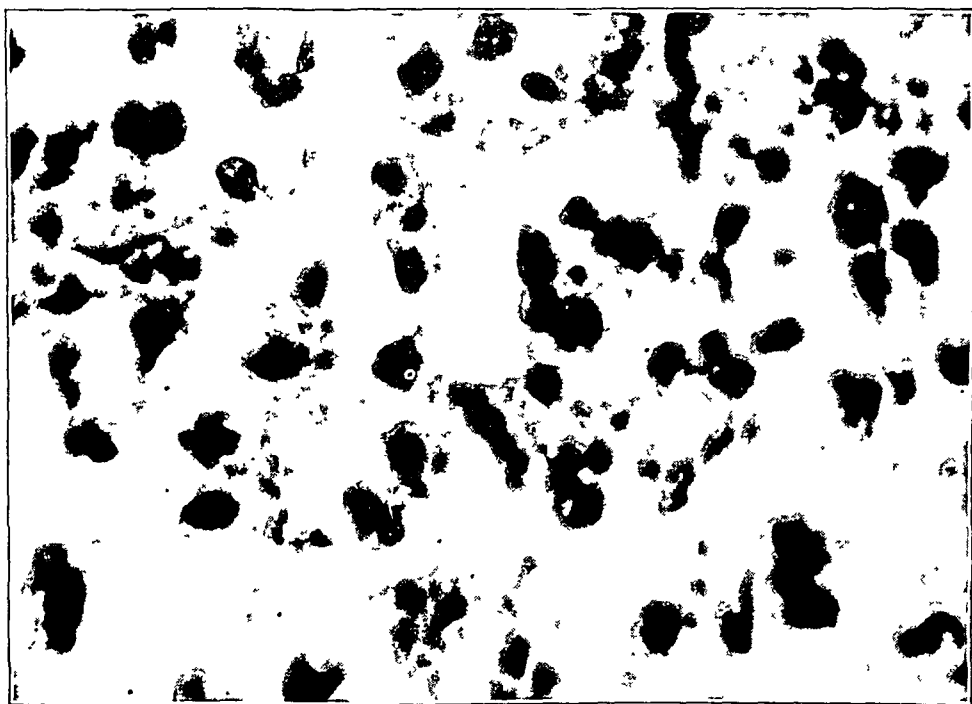


Fig. 5.—Photomicrograph with high power lens of section of the tumor especially stained to show the reticular stroma. The cells have irregular borders and thin protoplasmic projections. The cell nuclei are hyperchromatic. A rare multinucleated cell may be noted

in the process but lay over and superior to it. The pancreas was rather indurated and firm but suggested no acute process. There was a tremendous amount of clear transudate in the peritoneal cavity outside the cystic tumor. The mass seemed to arise inferior to the transverse mesocolon and measured about 17 by 20 cm. in its greatest diameter. The superior wall of the mass seemed to include a portion of the mesocolon. The mass was opened, and over 200 cc. of partially digested food was removed. The walls of the cystic mass were thickened and friable and did not bleed freely. A brownish secretion, suggesting bile-tinged fluid, began to flow into the cavity. The specimen taken for biopsy showed granulation tissue. Four drains were inserted in the cystic cavity, and

one drain was inserted external to the cyst wall, in the free peritoneal cavity. The abdomen was then closed, using stainless steel wire.

Postoperative Clinical Course.—On the second postoperative day, the patient began to show signs of being moribund. With the use of plasma proteins, blood transfusions and dextrose solutions, his condition improved. A special suction apparatus, devised by the house staff, functioned efficiently in keeping the patient's abdomen dry. All secretion was collected and measured as an aid in determining fluid replacement needs.

The patient had improved so much that on the fifth postoperative day an enterostomy was performed through a small incision in the left rectus muscle, and a catheter was inserted for feeding the patient. On the ninth postoperative day



Fig. 6.—Photomicrograph showing the invasion of the jejunal wall by lymphosarcoma. This portion of the bowel adjoined the aneurysmal dilatation of the duodenum.

there was partial disruption of the incision in the right rectus muscle. The wound was repaired with through and through sutures of braided silk. At this time evidence of mild jaundice became apparent. The icteric index was 60. The urine gave a positive reaction for urobilin and urobilinogen.

Every effort was made to maintain the food intake at a level of 2,500 calories, given through the enterostomy tube and parenterally. The patient received from 200 to 300 Gr. of protein daily. Maintenance of the fluid balance was a problem, and careful checks were made periodically in order that both the fluid and the electrolyte balance might be maintained.

During his stay in the hospital, the patient's condition fluctuated from day to day. There were periods of drowsiness and listlessness which did not seem to be

correlated with the fluctuating nonprotein nitrogen of the blood. On September 22, the fifteenth day after operation, the wound again ruptured, with partial evisceration, and the condition was handled conservatively by strapping. Increasing amounts of fluid were noted in the abdomen. The abdominal cavity was tapped, and 3,500 cc. of straw-colored fluid was obtained. Peripheral edema appeared, and it was obvious that the patient was losing ground. On September 23, the sixteenth postoperative day, he became drowsy and was mentally confused at times. Bloody fluid, at first bright red and later dark brown, began to drain from the site of the cystic cavity. On September 24 his condition became grave, and on September 25, the eighteenth postoperative day, he died.

During the course of the patient's hospitalization, the true nature of the disease was not known.

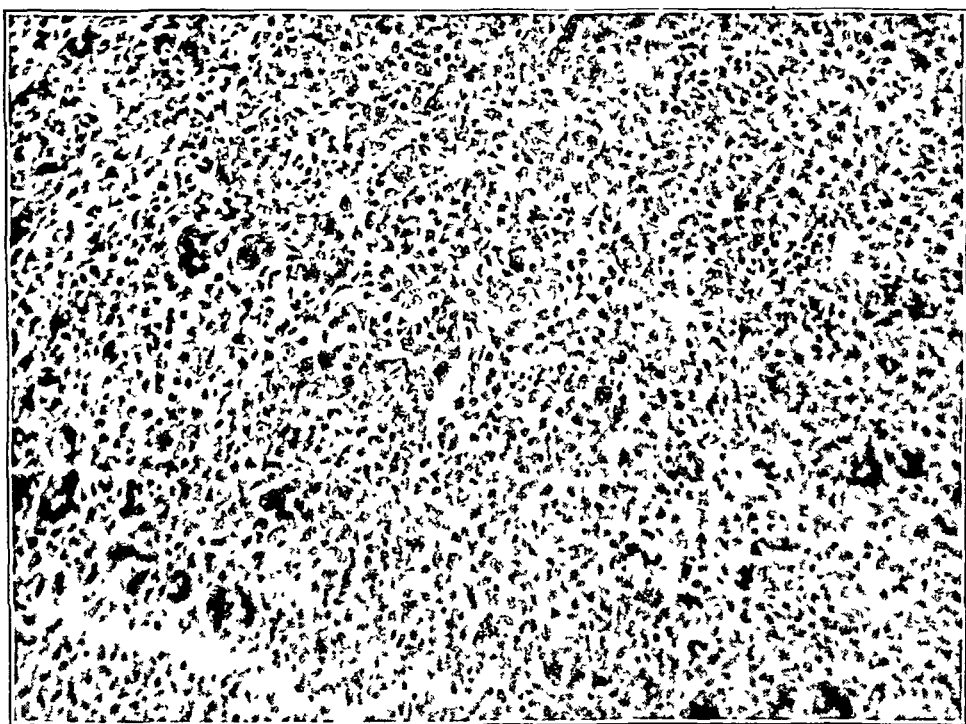


Fig. 7.—Photomicrograph of a section of the pancreas invaded by tumor tissue, which in some areas was largely replaced with lymphosarcoma.

Necropsy was performed on September 26.

Summary of Autopsy Observations.—The skin had a definite icteric discoloration. The abdomen was conspicuously distended; a midline surgical incision, 16 cm. in length, was open over its lower two thirds. There was slight edema of the lower extremities.

The abdomen, when opened, contained approximately 6,000 cc. of bile-tinged fluid. This fluid was pocketed in two areas, the upper part of the abdomen and the pelvis. In the midportion of the abdomen, there was a large space, approximately 20 cm. in diameter, which contained considerable clotted blood and which communicated with the wound in the abdominal midline. This space was lined with a thick yellow and gray inflammatory wall, composed partially of omentum

anteriorly, loops of small bowel and mesentery posteriorly and the transverse colon along the upper border. These observations indicated a walled-off perforation of the tumor. The mass was densely adherent to the anterior abdominal wall, and dissection of the intestinal tract was accomplished with difficulty. There was considerable fibrinous exudate on the surface of the small intestine and over the right dome of the liver.

On close examination, the terminal portion of the duodenum was observed to enter the left upper portion of the mass, where it opened in direct communication with the aforementioned cavity. This opening measured about 4 cm. in diameter. At a point 4 cm. below the duodenal opening a small opening, 1.2 cm. in diameter, lead from the cavity and communicated directly with the first portion of the jejunum (fig. 3). The pancreas was closely adherent to the posterior portion of the inflammatory mass over the head and the anterior part of the body. The mesenteric, retroperitoneal, preaortic and pelvic lymph nodes were enlarged.

The brain, lungs, heart, spleen, liver, pancreas, bladder and prostate gland showed no gross evidence of metastasis.

The stomach, when opened, showed nothing of note. It contained a small amount of tenacious mucus. The duodenum showed congestion and entered the inflammatory mass, as previously described. The jejunum showed nothing of note except in the lower portion, where there were several discolored, dark red areas in the mucosa. The lumen of the jejunum, ileum and colon contained a foul-smelling, dark gray, purulent material.

Anatomic Diagnosis.—The diagnosis was (a) destruction of the distal portion of the duodenum with formation of an aneurysmal cavity in the tumor; (b) perforation of the duodenum in the distal half with localized peritonitis; (c) lymphadenopathy (mesenteric, retroperitoneal, preaortic and inguinal); (d) moderate congestion of viscera, and (e) generalized icterus.

Microscopic Examination.—Tumor and Intestine (figs. 4, 5 and 6): Multiple sections of the tumor revealed cells of the reticular type embedded in, and separated by, a fine reticular stroma. The cells had irregular borders and thin protoplasmic projections. These were more evident with special stain. The nuclei of the cells were hyperchromatic, and many were indented or folded. Scattered multinucleated tumor cells were seen, but these were rare. The tumor replaced all normal architecture of the intestine and the lymph nodes. It was widely infiltrative.

Pancreas (fig. 7): Both acini and islets were normal in some areas. In most of the section there was infiltration by malignant tumor cells, which were irregular in outline, with single, hyperchromatic nuclei; and many of the cells showed cytoplasmic projections. A reticular stroma was present in the tumor tissue.

Microscopic Diagnosis.—The microscopic diagnosis was reticulum cell sarcoma of the duodenum, with extension to the mesenteric, retroperitoneal, preaortic and inguinal nodes and to the pancreas.

COMMENT

Lymphosarcoma is a true neoplasm arising in lymphatic tissue. It may be either a localized or a diffuse process and is distinguished from other forms of lymphoma by its local destructive capacity and by the

formation of true metastases in distant organs. Kundrat,^{1b'} in 1893, first recognized it as a disease distinct from pseudoleukemia. Except for his contention that the extension was solely by permeation of lymphatic vessels, his criteria for diagnosis are still eminently satisfactory.

At first, the disease is largely confined to the lymphatic system. A chain of lymph nodes may be affected, with contiguous nodes successively involved; less frequently, widely separated groups of nodes become involved in rapid succession, or even simultaneously. The spread of the process may be lymphatic, hematogenous or by direct extension.

Sugarbaker and Craver^{11"} have classified lymphosarcoma as a process either of monocentric origin or of multicentric origin. The disease as a process of monocentric origin is limited to a localized area in the beginning and may be attacked radically by surgical measures or by irradiation. Primary intestinal lesions fall into this group. As a process of multicentric origin, multiple areas become involved simultaneously. They may spread by the lymphatics and show true metastatic growths in other organs.

Gross Pathologic Features.—Lymphosarcoma may appear grossly as (a) a polypoid lesion, (b) an infiltrating annular lesion in the intestinal wall with thickening and little evidence of constriction, (c) a stenosing annular lesion, usually associated with extensive infiltration of the intestinal wall, or (d) an aneurysmal dilatation at the site of the tumor or above it. The annular and polypoid varieties of growth may be present together. The annular type is commoner than the polypoid. The polypoid lesions frequently are multiple.²

In many cases there is a decided tendency to aneurysmal dilatation at the site of the tumor. This dilatation is explained on the basis of the nature of the lymphosarcoma, which, by its aggressiveness, destroys the intestinal wall; because of its lack of fibrous structure, permits dilatation of tumor structure, and, because of its infiltrative character, destroys nerve supply to the regional muscularis. Dilatation of the bowel is seen frequently above the tumor, as a result of partial or complete obstruction at the site of the lesion. Stenosis of the bowel in lymphosarcoma is seen much less frequently and, as a rule, is dependent on a fibrosis reaction (as in our case) or on compression by mesenteric lymph nodes.³ Intussusception⁴ is not a

2. Assman.^{1a} Crowther.^{1m} Frank, Miller and Bell.^{1a} Geschickter.^{1x} Present.^{1y'} Raiford.^{1b"} Svien and Rivers.^{1m"} Ullman and Abeshouse.^{1o"}

3. Fraser.^{1v} Morrison.^{1q'} Staemmler.^{1k"} Ullman and Abeshouse.^{1o"} Weinstein.^{1r"} Winkelstein and Levy.^{1u"}

4. Kasemeyer.^{1e'} Raiford.^{1b"} Ullman and Abeshouse.^{1o"}

problem in cases of lymphosarcoma of the duodenum. Perforation of bowel invaded by lymphosarcoma occurs occasionally in any portion of the gastrointestinal tract. Lewis^{1b'} reported 6 instances from the literature, with a case of his own. In addition to its occurrence in our case, perforation of the diseased bowel as a complication is indicated in a few other cases reported in the literature.⁵ Lymphosarcoma is rarely associated with other types of tumor in the intestine.

Histopathologic Fracture.—Applying the principle of morphology as a basis for the classification of lymph nodes, Elwing¹⁸ designated two types of lymphosarcoma: (a) reticulum cell sarcoma, probably arising from the reticulum cell of the germ centers, of follicles or of pulp cords and (b) malignant lymphocytoma, the lymphocyte being the cell of origin.

Various classifications⁶ are available for lymph nodes, some of which have considerable merit; but we feel that until the basic facts known about the tumors of lymphoid tissue are increased, the classification given here is highly satisfactory for lymphosarcoma.

Reticulum cell sarcoma is much the commoner of the two pathologic conditions. The structure of this tumor presents a diffuse growth of lymphoid cells lying in reticular tissue. The structure of the affected node or follicle is largely obliterated. The cells vary in size from small to large. The nuclei may be either compact or vesicular. Nucleoli are not prominent, but hyperchromatism is a constant feature. Large multinuclear cells are occasionally seen.

Malignant lymphocytoma presents the picture of proliferation of lymphocytes, the reticulum remaining passive. Uniformity of cells, the aggressive characteristics of the lesions and widespread metastases help to distinguish it from other forms of lymphoma, of which pseudoleukemia and lymphatic leukemia are examples.

The earliest stages of lymphosarcoma begin in the follicles of the submucosa as a local thickening of the submucosa, with or without ulceration. The process extends laterally and invades and destroys the muscularis. It may appear as a subserous tumor. The intestinal wall may become diffusely thickened and tubelike. Thereafter, central ulceration excavates the tissue or produces aneurysmal dilatation, which, with peripheral growth, yields a large tumor with a roomy cavity. Less frequently does one find marked stenosis. Polypoid lesions in the intestinal lumen are fairly frequent.

Incidence.—An extensive review of the literature compels us to admit that an accurate compilation of cases of primary lymphosarcoma

5. Cheever.^{1j} Davies.^{1o} Fraser.^{1v} Hulbert.^{1c'} Morrison.^{1q'} Oettle.^{1u'} Pissarewa.^{1w'} Premoli.^{1x'} Usher and Dixon.^{1p''} Weber, Kirklin and Pugh.^{1q''}

6. Callender.^{1f} Gall and Mallory.^{1w} Graves.^{1z}

(monocentric origin) of the duodenum is impossible. Certain generalizations of value may be made. Lymphosarcoma is more frequent in the small intestine than in the large bowel, including the rectum, the ratio being approximately 2:1.

A review of the literature from 1932 to 1947 yielded the following statistics, in order of the frequency of the anatomic location. 1. Single primary lesion: ileum, 78 cases; jejunum, 29 cases; duodenum, 9 cases, and duodenojejunal angle, 4 cases. 2. Multiple involvement: duodenum and stomach, 2 cases; jejunum and ileum, 2 cases; ileocecal region, 4 cases, and "small intestine," 4 cases.

Comparison of these figures with the statistics of Ullman and Abeshouse^{10'} and others does not alter the order of frequency for the anatomic sites. Prey, Foster and Dennis,^{12'} in a review of the literature in 1935, found 61 authentic cases of primary sarcoma of the duodenum, in 34 of which the tumor was a lymphosarcoma. Comprehensive reviews of earlier authors are those of Goldstein,^{13'} Crowther,^{14'} Libman^{15'} and Staemmler.^{16'}

Sex: Males show a greater predisposition to the disease than do females, the ratio being approximately 3:1. The disease is more likely to develop in Caucasians than in Negroes, the ratio being 4:1.

Age Distribution: Lymphosarcoma may occur at any age but is most frequently found in the first, third and fourth decades of life. The number of patients with lymphosarcoma of the small intestine in the first decade of life is striking.⁷

Metastases.—Lymphosarcoma spreads by direct invasion, by the lymph nodes and by the hematogenous route. The growth tends to spread early to lymph nodes in the mesentery of the part of the intestine involved. This poses a serious complication in the successful surgical extirpation of the disease. In advanced cases, practically every organ has been found to be involved. Some metastases are noted in almost every case in which complete studies have been made on patients not successfully treated. The hematogenous route is necessary in accounting for many of these secondary deposits.

Symptoms and Findings.—Tumors of the small intestine do not produce a characteristic clinical syndrome; primary lymphosarcoma is no exception. The type and character of the symptoms are varied and appear to be dependent on the location of the lesion, the rapidity of growth, the degree of intestinal obstruction and other complications caused by it. There are three main clinical pictures: 1. The patient presents symptoms of vague abdominal distress, postprandial bloating,

7. Charache.^{1b,1} Cutler, Stark and Scott.^{1a} Lewis.^{1b'} Simpson-Smith.^{1b''}

pain in the epigastric or umbilical region and, frequently, various degrees of anemia and weakness. The patients are thin and cachectic, especially when the tumor has been of long duration. Bowel movements are frequently irregular. The stools occasionally contain blood or mucus. Mild constipation, alternating with diarrhea, may be a feature. Nausea and vomiting are commonly present. 2. Recurrent attacks, suggesting obstruction but clearing in two or three days, may ultimately give the picture of chronic obstruction. 3. Subacute or acute intestinal obstruction may develop either without previous difficulty or superimposed on milder abdominal distress of longer duration. The duration of symptoms may vary from a few hours to several years.

In cases of duodenal lesions the abdominal findings are not constant. Diffuse or localized tenderness is usually present. A mass is rarely felt. Abdominal distention in varying degrees may be noted. There is usually little, if any, rigidity.

Hematologic Studies.—Hemograms reveal little of value. Sugarbaker and Craver¹¹ found only 10 per cent of patients with lymphosarcoma with a hemoglobin of less than 70 per cent and only 23 per cent of patients with mild leukocytosis, with a white cell count above 10,000. There is no indication that the white cell count reflected any suggestion of lymphoid leukemia. In our patient, the hemoglobin was 55 per cent and the white cell count 7,600, with 91 per cent polymorphonuclear cells.

Roentgenographic Diagnosis.—The finding of defects in the upper intestinal tract has improved in the last two decades with more accurate methods of study. There is no characteristic roentgenographic picture of lymphosarcoma in any part of the intestinal tract. Weber, Kirklin and Pugh,¹² in an excellent discussion, pointed out that even a review of roentgenograms taken of patients known to have lymphosarcoma gave no tangible clues that diagnosis can be improved. In 19 of 25 cases, they made an unqualified diagnosis of carcinoma of the bowel; in 1 case the diagnosis was polypoid tumor, and in 3 cases the lesions were called an ulcerating malignant growth. In duodenal lesions, dilatation of the stomach and duodenum may be observed rarely; deformity of the duodenal cap, disturbance of mucosal pattern, polypoid defects and narrowing or indeterminate changes may be seen. Pressure defects of the duodenal bulb, distortion of normal duodenal swing and defects on the greater curvature of the antrum of the stomach may occasionally also be found. When the clinical picture suggests obstruction, a roentgenologic examination without the use of opaque substances may show a dilated stomach and the intestine filled with gas. The use of the Miller-Abbott tube in conjunction with roentgenographic studies has yielded helpful information. After the tube has successfully passed into the duodenum,

a thin, standard opaque mixture, which may outline a deformity or narrowing, is passed through the tube. Such a mixture can readily be withdrawn; in this way the danger of obstruction is minimized.⁸

Treatment.—The successful treatment of primary lymphosarcoma of the intestine depends on early diagnosis and the institution of prompt treatment. Unfortunately, the treatment of lymphosarcoma of the duodenum apparently has been uniformly poor. Many cases have been reported before sufficient time has elapsed to determine the outcome of the treatment. A review of the literature showed a survival rate of from a few days to forty-eight months or longer after operation for patients with lymphosarcoma of the duodenum. Many of these patients have since died, whereas others were without evidence of disease at the time of the reports. In cases of lymphosarcoma of the ileum and jejunum, survivals up to nine years without evidence of disease have been reported. The survival rate improves for patients with lesions in the lower portion of the small intestine, especially the ileum. The anatomic relationship of bowel, mesenteric nodes and retroperitoneal nodes undoubtedly plays a significant role in the prognosis. This is due to the fact that it is possible to resect some of the earlier lesions in the ileum and jejunum which may have extended to the mesenteric nodes and yet have not extended into the retroperitoneal area. In the case of the duodenum, because of its anatomic relationship to surrounding organs and the retroperitoneal nodes, it apparently has been possible only rarely to resect the diseased bowel in this area before it has extended into the contiguous organs or tissue.

Treatment may be (a) definitive or (b) palliative. Definitive treatment is directed toward the complete removal of the disease surgically. If this does not appear possible at operation, a side-tracking procedure is indicated. There is much controversy over the efficacy of irradiation in the treatment of lymphosarcoma of the intestinal tract. However, in a careful analysis of selected reports which contain adequate information, one may conclude that irradiation as a palliative measure should be used whenever possible in cases in which definitive surgical treatment cannot be accomplished, and should be carried out in cases of the operable lesions to prevent recurrence and metastasis.⁹

SUMMARY

A case of reticulum cell lymphosarcoma of the third portion of the duodenum, with aneurysmal dilatation and subacute perforation, is

8. Greenfield.^{1a'} Holmes, Dresser and Camp.^{1b'} Moreton.^{1p'} Present.^{1s'} Prey, Foster and Dennis.^{1z'} Svien and Rivers.^{1m''} Swenson.^{1n''} Weber, Kirklin and Pugh.^{1q''} Weintraub and Tuggle.^{1s''}

9. Chont.^{1k} Desjardins and Ford.^{1p} Minot and Isaacs.^{1o'} Sugarbaker and Craver.^{21''} Ullman and Abeshouse.^{1o''}

reported. Stenosis of the jejunum at the distal end of the tumor process and extension of the growth into the pancreas and the regional lymph nodes were additional complications.

The pathology, symptomatology, physical observations, roentgenographic findings and treatment of lymphosarcoma of the duodenum are discussed.

- The literature on lymphosarcoma of the small bowel is reviewed, especially that between the years 1932 and 1947.

Department of Oncology, Georgetown University School of Medicine, Washington, D. C., 7. (Dr. Copeland)

BENIGN NONEPITHELIAL TUMORS OF THE STOMACH

JACOB RABINOVITCH, M.D.

DAVID GRAYZEL, Ph.D., M.D.

ALFRED J. SWYER, M.D.

AND

BERNARD PINES, M.D.

BROOKLYN

THE MATERIAL for this analysis was obtained from the records of the Jewish Hospital during the past twenty years and includes 20 cases of benign tumors of connective tissue and smooth muscle origin. It is of interest to note that during the same period there were observed at the hospital 11 cases of benign epithelial growths of the stomach and 9 cases of malignant nonepithelial tumors. The evidence in our material points to the fact that the benign nonepithelial growths of the stomach are twice as common as the benign epithelial growths and approximately two and a half times as common as the malignant connective tissue neoplasms. Some of the patients gave a history of gastric disturbances which may well have been due to the presence of the tumor, but none of these manifestations could be considered pathognomonic. Abdominal pain of variable character was the most common complaint. A palpable mass was an infrequent finding; it was definitely palpated in 1 instance and questionably in another. Few patients, indeed, presented clinical evidence indicative of gastric neoplasm. Many of these growths were found incidentally at autopsy or during exploratory operations for other lesions in the gastrointestinal tract.

There is no notable sex predilection for these neoplasms of the stomach, although, as for tumors in general, males may be slightly to the fore. Of the 20 patients reported on here, 13 were men and 7 were women. The majority of these tumors have been reported to occur between the ages of 30 and 40 years, but the age incidence is wide, ranging in this series between 37 and 77 years, with an average of 60 years.

There are no definite criteria to guide one to a diagnosis of these gastric neoplasms. The tumors rarely grow to a size sufficient to cause symptoms due to pressure or to interfere with the normal function of the stomach.

From the departments of laboratories and surgery, Jewish Hospital of Brooklyn.

INCIDENCE OF DIFFERENT FORMS

An outline of the different forms of the tumors described in this paper is given in the accompanying table. It is evident that leiomyoma is more frequent in occurrence than the other forms of benign tumors of the stomach; it occurred in 12 instances, or in 60 per cent of the cases. The other forms occur more rarely and are of little clinical significance except that they may grow at times to an unusually large size and cause symptoms because of pressure.

Leiomyomas.—Clinically, not all myomas of the stomach give rise to symptoms. Many of these tumors are discovered accidentally at autopsy; only few present symptoms referable to the lesion. It is stated that the outstanding clinical features of the reported cases of leiomyoma of the stomach are mechanical obstruction and gastric bleeding. Repeated episodes of melena are found in an appreciable number of instances; they were found three times in the present series. The bleeding is due

Incidence of Tumors in 20 Cases

Leiomyoma.....	12
Fibroma.....	5
Neurofibroma.....	1
Lipoma.....	2

primarily to ulceration of the surface of the tumor. The less common clinical manifestations of the lesion are pain, dyspepsia, loss of weight and symptoms resulting from secondary anemia. A mass is infrequently felt on abdominal palpation, because the tumor rarely becomes large enough to be felt. Roentgenologic examination in many instances is of assistance in the diagnosis of the gastric tumor, but this is by no means true in all cases.

In the present series of leiomyoma of the stomach only 2 patients presented symptoms referable to the lesion. One case concerned a 61 year old man who complained of having lost 25 pounds (11.3 Kg.) in weight during the previous six years. Physical examination revealed a sense of resistance just above and to the left of the umbilicus; the abdomen otherwise was essentially normal to palpation. Gastric analysis disclosed normal acidity. The stools revealed evidence of occult blood on chemical analysis. Roentgenologic examination showed a filling defect in the pyloric end of the stomach. The clinical impression was that of carcinoma or peptic ulcer of the stomach. At operation there was a nodular mass in the pylorus, 9 by 7.2 by 6.5 cm., with an ulcerated surface. On microscopic examination the tumor proved to be a leiomyoma.

The second case concerned a 53 year old man who complained of epigastric pain and constipation of several months' duration. Abdominal examination revealed nothing significant. Gastric analysis showed normal acidity; the stools contained occult blood. Roentgenologic examination of the gastrointestinal tract was noncontributory. The clinical impression was that of carcinoma of the duodenum, and at operation there was a nodular, circumscribed, firm mass in the pyloric portion of the stomach which was 4 by 2 by 2 cm. The free surface of the mass was ulcerated and bleeding. Microscopic examination of the tumor revealed a typical picture of a benign leiomyoma.

The remaining 10 tumors of leiomyoma were incidental findings at operation or at autopsy. In 1 patient a leiomyoma of the pylorus was found at operation together with a peptic ulcer in the same region. This patient, however, presented clinical evidence indicative of a peptic ulcer and not of the neoplasm. In another patient a leiomyoma of the stomach was found in association with a carcinoma of the colon. A third patient presented clinical evidence suggestive of a gastric lesion, the nature of which was not determined until he died as a result of a coronary occlusion, when at autopsy an ulcerating leiomyoma of the stomach was discovered. All the remaining patients presented no clinical manifestations of a gastric lesion, and the tumor in each instance was an incidental finding at necropsy.

Anatomically, the leiomyoma is a small, nodular growth, rarely exceeding a few centimeters in diameter. The largest tumor in this series measured 9 cm. in diameter and the smallest 1 cm. The tumor frequently arises in the muscular coats and tends to grow inwardly toward the lumen, where it may ulcerate the mucosa and cause bleeding. The most frequent location of the tumor is in the pylorus, although it may arise anywhere in the gastric wall. The tumor is often confused clinically with peptic ulcer or with carcinoma of the stomach.

The cell origin of this tumor is from the smooth muscle of the wall of the stomach. Both in cytologic detail and in architectural pattern the tumor mimics closely the smooth muscle tissue from which it arises and offers, therefore, little anatomic difficulty in diagnosis. Microscopically, it is made up of whorls and interlacing bundles of smooth muscle cells, a varying amount of fibrous supporting stroma being present. Necrosis, hyaline degeneration and hemorrhage into the tumor mass have been described but are rather infrequent findings. Only three of the tumors in this series showed ulceration of the surface and bleeding; in all the remaining cases there were no secondary changes (fig. 1).

Fibroma.—There were 5 instances of fibroma of the stomach in the present series, one associated with a gastric ulcer and another with carcinoma of the colon. In the remaining 3 cases the fibromas were

incidental findings at autopsy. None of the patients presented clinical evidence of a gastric neoplasm. The tumors were small, not exceeding 1 cm. in diameter. They were located either subserously or intramurally, and were firm, nodular and encapsulated. The cut surfaces of the tumors were of a homogeneous, gray-white appearance.

Microscopically, the tumors consisted of dense bundles of elongated cell fibers running in different directions but in an orderly fashion; the

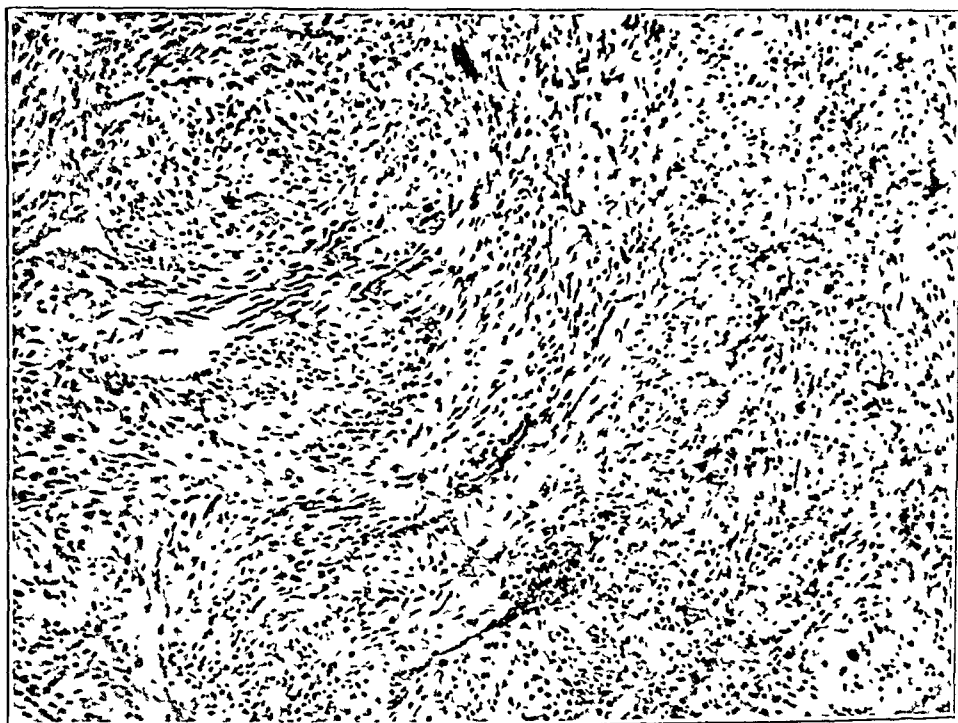


Fig. 1.—Photomicrograph of leiomyoma. Hematoxylin and eosin; $\times 100$.

nuclei were rod or spindle shaped. Areas of dense hyaline changes, with loss of cellularity and nuclear material, were also encountered at irregular intervals. One of the tumors showed scattered areas of hemorrhage (fig. 2 A).

Neurofibroma.—There was only 1 instance of neurofibroma of the stomach in this series. It occurred in a 38 year old woman who complained of epigastric pain and hematemesis. Abdominal examination was essentially noncontributory aside from the presence of a palpable, nodular mass just above the umbilicus. Gastric acidity was normal; gastric extraction showed the presence of gross blood. The hemoglobin content was 34 per cent but rose to 77 per cent after several blood transfusions. Roentgenologic examination of the stomach disclosed a pocket in the pars media of the greater curvature. The clinical interpretation was that

of ulcer or carcinoma of the stomach. At operation a lobulated, moderately firm mass was found in the submucosa of the greater curvature of the stomach. A subtotal gastrectomy was performed, and the patient made an uneventful recovery.



Fig. 2.—*A*, photomicrograph of fibroma. *B*, photomicrograph of neurofibroma. Hematoxylin and eosin; $\times 100$.

Gross examination of the specimen removed at operation revealed a nodular mass 9.5 by 8 by 5.5 cm. within the greater curvature of the stomach. The mucosa moved freely over the tumor; the latter was well

encapsulated. Cut section of the tumor showed a homogeneous, yellow-gray surface with scattered areas of necrosis and amber-colored detritus. Microscopically, it was made up of fascicles of fibers with rod-shaped or slightly oval nuclei, with typical palisade formation characteristic of neurogenic tumors (fig. 2 B).

Since the recognition of neurofibroma as a separate entity, there has been no uniformity of opinion as to the etiology and origin of these rare growths of the digestive tract. It is believed by some observers that the fibrous tissue of the nerve sheath is the probable site of origin. A perusal of the literature shows that there is much uncertainty and confusion in the classification of these neoplasms. Lhermitte and Leroux¹ were able to identify tumors situated in the wall of the digestive tract, the structure of which appeared in all respects to be identical with that of growths occurring in the peripheral nerves and in the spinal nerve roots. Masson² felt that the fundamental constituent of the tumors is the schwannian syncytium, a neurectodermal structure and not a mesodermal fibroblast.

From a review of the recent literature, it is evident that there is still a difference of opinion as to the classification and histogenesis of these tumors. A satisfactory classification is difficult, owing to the complex structure of the nerve sheath tumors and the uncertainty of the source of the supporting cells which accompany the nerve fibers and which may participate in the growth of the tumor. Masson stated the belief that the cells of the neurilemma are the parent tissue. One must consider the possibility, however, that the tumors may grow not only from the sheath of Schwann but also from the connective tissue. A careful study of several sections taken at random from various parts of the tumor in our series failed to shed any additional light on the pathogenesis. We are inclined to believe, however, that the tumor arises in all probability from the neurilemma, with which it appears closely associated.

Neurofibromas of the stomach are regularly benign, though they occasionally manifest a low degree of malignancy. The mass is encapsulated and frequently pedunculated; most of the specimens described in the literature are often ovoid or spherical. Benign tumors are apt to be harder and firmer than their malignant counterparts.

Histologically, the tumors contain whorls of interlacing bundles of fibers with a frequent palisade arrangement, a distinctive appearance peculiar to growths known as neurofibromas.

1. Lhermitte, J., and Leroux, R.: Etude histologique générale des gliomes des nerfs périphériques des racines rachidiennes et des gliomes viscéraux, *Rev. neurol.* 7:286, 1923.

2. Masson, P.: Experimental and Spontaneous Schwannomas, *Am. J. Path.* 8:1, 1932.

Lipoma.—Two cases of lipoma of the stomach were noted in the present series, both occurring in persons past the age of 70 years. The tumors were incidental findings at autopsy, and the patients presented no signs or symptoms referable to them. One of the tumors was discovered in a 76 year old woman who also had an ulcer of the stomach. The other was found in a 71 year old man who died of carcinoma of the prostate. In each instance the tumor was small, soft, pedunculated and encapsulated, averaging 2 cm. in diameter. Microscopic examination of the specimens removed at autopsy revealed a typical lipomatous structure. The entire tumor was made up of closely packed polygonal cells with little supporting fibrous tissue stroma (fig. 3).

COMMENT

A review of the cases cited in this paper and those reported in the literature demonstrate clearly that the diagnosis of benign nonepithelial tumors of the stomach is often beset with many difficulties. The signs and symptoms are by themselves not distinctive and are similar to those associated with other gastric lesions. The laboratory tests, although of great value, are by no means infallible.

Analysis of the diagnostic facts relating to these tumors shows that only a small number of the patients present symptoms referable to the lesion. Many of the patients cited here were symptom free and the tumor was discovered incidentally at autopsy or during exploratory operations for other gastrointestinal lesions. The patients who presented symptoms referable to the stomach disclosed that abdominal pain was perhaps the most important single complaint; it varied from a sensation of fulness to sharp abdominal pain and was mostly referred to the epigastrium or immediately around it. Most of the symptoms were due to obstruction or to bleeding resulting from ulceration of the surface of the tumor.

Practically all the patients operated on presented past histories which may have had bearing on their illness. Some experienced transient attacks of pain which varied in duration from several weeks to several months. The patients were mostly well nourished; only 1 patient lost considerable weight. One patient appeared acutely ill on entering the hospital. Tenderness over the affected area was elicited in 2 patients. A palpable mass in the epigastrium was noted in 1 patient and questionably in another.

The laboratory data were not at all conclusive. In cases in which the tumor was ulcerated and bleeding the patients manifested signs of secondary anemia. Also, occult blood was found in the stools or free blood in the material aspirated from the stomach. Gastric analysis, whenever done, showed normal acidity. Roentgen examination was a major aid in the diagnosis of the tumors. It revealed the presence of a

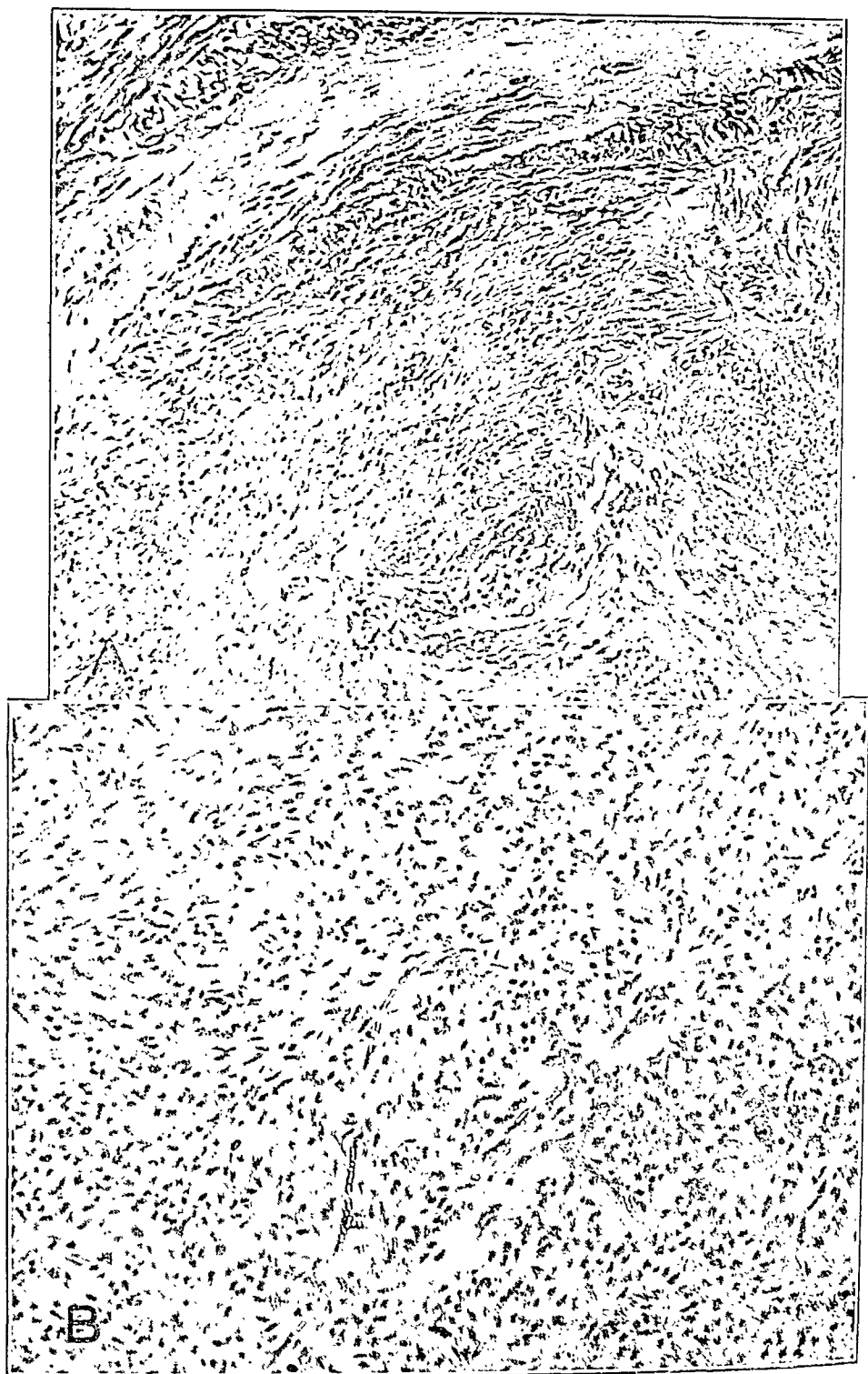


Fig. 3.—Photomicrograph of lipoma. Hematoxylin and eosin; $\times 20$.

defect in the stomach indicative of a gastric lesion, although its true nature could not be definitely ascertained from the roentgen examination alone.

The general peculiarities shown by these patients enable the following brief summary to be made: A diagnosis of the lesion may be entertained in view of the age of the patient, the short clinical history, the normal gastric acidity, roentgen studies, maintenance of good nutrition and the presence of a palpable abdominal mass. These factors, considered singly or in combination, should lead one to suspect the lesion. This holds true particularly in the case of leiomyoma and neurofibroma of the stomach. Lipomas and fibromas, on the other hand, rarely give rise to symptoms indicative of their presence. Since myomas and neurofibromas are often associated with mucosal ulceration, bleeding is an important item in the clinical history. There were no instances in this series of emergency surgical intervention for acute massive hemorrhage as is sometimes seen in cases of gastric ulcer or carcinoma.

As has already been noted, these tumors are often closely mimicked by other gastric disturbances, notably peptic ulcer and malignant growth of the stomach. This is mainly due to the fact that they are located in the pyloric or prepyloric region, where gastric ulcer and carcinoma are most commonly found. Also, the tendency for the tumors to cause mucosal ulceration and bleeding complicates the picture still further. The tumors, however, display certain features which are lacking in both peptic ulcers and malignant growths of the stomach and which exert an important influence on the management of the disease. The general tendency for patients to maintain good nutrition and normal acidity and the short duration of symptoms at once preclude malignant tumors of the stomach. Similarly, the lack of a definite clinical history of peptic ulcer and the absence of a high gastric acidity speak well against peptic ulcer. The clinical results of operative treatment of these benign tumors of the stomach are also better than those in cases of either gastric ulcer or carcinoma.

The pathologic picture presented at operation is rather striking. The tumor usually appears as a nodular, relatively immobile, firm mass in the pyloric or prepyloric region of the stomach. It is usually confined to the muscular coats or submucosa, and the overlying mucosa is freely movable over it. Ulceration of the surface is relatively frequent and gives rise to bleeding. The tumors being benign, they are usually well encapsulated and can be enucleated.

The histologic descriptions of these tumors in the literature are similar to those in our series. It seems unnecessary, therefore, to repeat the histologic picture in detail, but a few points might be reemphasized. In the case of leiomyoma, the tumor is made up almost entirely of whorls and interlacing bundles of smooth muscle fibers enclosed within a well

formed capsule of fibrous tissue. The tumor mimics closely the mother tissue from which it arises and offers, therefore, little difficulty in diagnosis. The fibromas offer little difficulty in anatomic diagnosis. They are made up of dense collections of fibroblastic tissue which often become hyalinized and lose their cellularity and their nuclear material. The neurofibromas are of particular academic interest because of their infrequent occurrence and peculiar histologic structure. The tumor cells form whorls of interlacing bundles with a characteristic palisade arrangement, a feature which renders their histologic diagnosis simple. The lipomas show a typical microscopic picture peculiar to all fatty tumors. The growth is made up of closely placed fat cells with little connective tissue stroma to support them. These tumors in the stomach are usually small and rarely give rise to any symptoms.

The question of classification of the tumors has more than academic significance, as it bears largely on the form of treatment to be adopted. While benign tumors may be removed by simple excision, malignant tumors, on the other hand, require considerably more extensive surgical intervention to assure a cure. Choice of operation depends on the size, the variety and the situation and on the condition of the patient. The ideal treatment is complete removal if possible. Small tumors, especially when encapsulated, may be readily enucleated with little interference in gastric continuity or gastric function. When the tumor is unusually large and the question of malignancy arises, wide resection of the tumor-bearing portion of the stomach, with reestablishment of gastrointestinal continuity, may become necessary.

Little need be said of the prognosis in cases of these tumors. Since they are benign they can be removed with low mortality rate and with little fear of recurrence.

SUMMARY

Twenty cases of benign, nonepithelial tumor of the stomach are reviewed. In 12 of these the lesion was leiomyoma, in 5 fibroma, in 1 neurofibroma and in 2 lipoma.

The diagnosis of these tumors is difficult because of the similarity in signs and symptoms to other gastric lesions. The essential features presented by them are generally described.

The main histologic characteristics of the various forms of the tumors noted in the present series are described.

Surgical Forum

ROBERT ELMAN, M.D.

ST. LOUIS

From a number of questions submitted, the following were selected because of their common application to technical problems concerning gastric resection for duodenal ulcer. These questions were submitted to the editors, and the answers are summarized. It should be emphasized that this forum is meant to be informal as well as informative. Review of the literature or dogmatic answers are not its goal but rather ideas, experiences and opinions which may in turn stimulate careful and scientific investigation and thus lead to deductions of lasting therapeutic value.

Readers are invited to report their findings, whether in agreement or not, and to submit experiences as well as further questions about this or other general surgical problems.

1. In the performance of a partial gastrectomy for duodenal ulcer, is there convincing evidence that excision of the ulcer (aside from cases of massive hemorrhage) leads to better clinical results?

Only one editor deviates from an unequivocal negative answer by stating that there is slight evidence in favor of excision of the ulcer. However, the details of this evidence are difficult to obtain. One of the important reasons suggested was the difficulty in separating the cases in which the ulcer was excised from those in which it was left, even by careful examination of the specimen. Thus the surgeon may describe excision of the ulcer, yet the pathologist may fail to find it. This, however, is no proof that the ulcer was not removed, inasmuch as crushing clamps are frequently applied over the ulcer, leading to its removal from the patient yet preventing its identification by the pathologist.

Further comment emphasizes the possibility of leakage at the duodenal stump when the ulcer is broken into during the dissection. The mortality rate, after gastrectomy, improved when surgeons ceased trying to excise the duodenal ulcer in certain cases in which the procedure proved difficult. On the other hand, the removal of all antral cells down to the pylorus is extremely important.

Whether actual perforation occurs in cases in which the ulcer has been definitely left has not been reported in a large series; however, it must be unusual, although one editor describes an experience in which this accident occurred during the early postoperative period.

2. Could you refer to any follow-up information proving that the amount of stomach removed (in addition to the prepyloric region) influences the more permanent relief of symptoms?

Removal of all antral cells is a *sine qua non*. This is probably due to the need for eliminating the effect of these cells which seem to stimulate the secretion of acid gastric juice. Excision of the cells probably also stops the production of lysozyme, a ferment which apparently dissolves the protecting mucin normally secreted by the rest of the stomach and which thus is said to be a factor in the pathogenesis of ulcer.

Wide resection is favored by all, with emphasis on the lesser curvature by one and on the fundus by another. One editor reports an excellent follow-up study of patients operated on between 1940 and 1946, who were divided into two general groups, one subjected to "high" resection and the other to "low" resection. Proved jejunal ulcer was found in but 2 per cent of the former and 8.3 per cent of the

latter. Moreover, from the evaluation of the late results and the application of rigid standards, it was observed that the high resection gave (among those surviving operation) 81 per cent over-all satisfaction, in contrast to 71 per cent for the low resections.

One of the difficulties in answering this question stems from unavoidable inaccuracy in the use of terms. It is almost impossible to place the meanings of "wide," "high," "low," "partial" "subtotal" resection on an exact quantitative basis although many attempts have been made. Roentgenologic comparisons of preoperative and postoperative barium fill-up in patients with no gastric distention might be worth while investigating (see also Walters, W., and Taylor, E. R.: Gastric Resection for Duodenal Ulcer, Questions and Answers, Arch. Surg. 57:697 [Nov.] 1948).

3. In the performance of a posterior gastroenterostomy after resection, does it make any difference whether the lesser curvature is placed proximal or distal to the greater curvature?

No unanimity was apparent, although there is a definite preference for the anastomosis in which the distal jejunum lies in juxtaposition with the greater curvature. Variations in this detail may depend considerably on variations in the anatomic relationships found in individual patients, emphasis being placed on avoiding any kinking of the proximal jejunum lying between the ligament of Treitz and the anastomosis. A preference is expressed for as short a loop of proximal jejunum as possible. On the other hand, the point is made that many types of anastomoses, including antecolic, with or without enteroenterostomy are described in the literature by surgeons, with apparently excellent postoperative results.

Mention should be made of the possibility of allowing the stump of the stomach to rotate as it will so that the site of both the lesser and greater curvatures may be sutured not necessarily at each end of the anastomosis but at its anterior or posterior row. Perhaps this should be investigated in a series of cases.

4. On what factors does the early restoration of oral intake after gastrectomy depend?

Careful and complete preoperative and postoperative care is stressed, with special reference to the avoidance of edema rather than to purely mechanical factors. The prevention or correction of edema depends first of all on adequate relief before operation of stagnation with its resultant inflammation in patients with pyloric obstruction. Almost as important is an adequate intake of protein to correct as much of the protein deficiency as possible by one or more of the presently available methods. A third and extremely important factor is the avoidance of excessive parenteral administration of sodium chloride solution, excessive being defined as any significant amount over and above the actual needs for replacement and maintenance.

PROGRESS IN ORTHOPEDIC SURGERY FOR 1946

A Review Prepared by an Editorial Board of the American Academy
of Orthopaedic Surgeons

XIV. DISEASES OF GROWING AND ADULT BONE

Prepared by
JOHN A. SIEGLING, M.D.
CHARLESTON, S. C.

Growth of Bone.—Very little was added to knowledge of this subject during the year 1946. Armstrong⁶⁸⁴ reports experimental work on rats in which one limb is completely denervated; at maturity the animal is killed, and the limbs are compared. As a result of his work, Armstrong concludes that paralysis of a limb interferes with appositional growth of bones more than with epiphysal growth, and that growth of bone is not prevented in the denervated limb.

Osteitis Deformans.—Of several reports, that of Newman⁶⁸⁵ is most valuable. Eighty-two cases are described. In only 48 per cent did the patients have complaints referable to osteitis deformans (Paget's disease); in the remaining 52 per cent the disease was an incidental finding. The pelvis was involved in the majority of cases, and in 12 only one bony structure was affected. Serum calcium and phosphorus determinations revealed little variation from normal. The level of alkaline phosphatase was elevated in 6 of 9 cases in which the examination was made; this test is considered by the author to be the most useful laboratory procedure in current use in establishing the diagnosis of Paget's disease. Complications observed in the series, considered in order of their frequency, were (1) pressure on the cranial nerves, (2) fractures, (3) urinary calculi and (4) sarcomatous degeneration. Magnesium carbonate U. S. P. produced symptomatic improvement in 6 of 8 cases in which it was tried; its use constitutes the only therapy of value.

Summey and Pressly⁶⁸⁶ give an excellent review of the clinical and microscopic picture of Paget's disease. The various possible etiologic

684. Armstrong, W. D.: Bone Growth in Paralyzed Limbs, Proc. Soc. Exper. Biol. & Med. **61**:358-362 (April) 1946.

685. Newman, F. W.: Paget's Disease: A Statistical Study of Eighty-Two Cases, J. Bone & Joint Surg. **28**:798-804 (Oct.) 1946.

686. Summey, T. J., and Pressly, C. L.: Sarcoma Complicating Paget's Disease, Ann. Surg. **123**:135-153 (Jan.) 1946.

factors are discussed. The value of the paper lies chiefly in the attempt of the authors to record all reported cases of sarcoma complicating Paget's disease; these number 76. The incidence of sarcoma in several reported series of cases varies from 2 to 14 per cent. In reported cases the femur, humerus, skull and tibia, in that order, are the bones most frequently involved. The authors report 3 cases of their own in detail, and state the belief that amputation is the treatment of choice where possible, considering the gravity of the prognosis.

Moehlig and Abbott⁶⁸⁷ call attention to the close relation of disordered carbohydrate metabolism to osteoporosis and Paget's disease. Studies of the blood were made in 94 cases of osteoporosis and in 40 cases of Paget's disease. Glucose tolerance tests revealed a diabetic type of curve in 35 of 40 cases of osteoporosis and in 27 of 31 cases of Paget's disease. The authors are of the opinion that since arteriosclerosis almost invariably accompanies both conditions, the administration of calcium and vitamin D is contraindicated.

In an interesting and thought-provoking article, Edholm, Howarth and McMichael⁶⁸⁸ present data which indicate that in generalized Paget's disease there occurs an increase in the blood flow in the bone of sufficient magnitude to produce effects on the general circulation similar to those resulting from free arteriovenous communications.

Fibrous Dysplasia of Bone.—Interest in the fibrous conditions of bone continues and will continue for some time to come, and there is still diversity of opinion. Murray, Kirkpatrick and Forrai⁶⁸⁹ report a case of Albright's syndrome. It is of particular interest in that it occurred in a male patient who presented progressive fibrous dysplasia, roentgenologic changes and absence of changes in the blood suggesting parathyroid adenoma and of pigmentation of the skin. Pronounced clinical deformity of the bones of the lower extremities was present and prevented ambulation. The patient was made ambulatory with braces by excision of segments of bone, so as to prevent stress on vessels and nerves at the time of correction of the deformities.

Patten⁶⁹⁰ reports an incomplete form of Albright's syndrome without precocious puberty and pigmentation of the skin. The total number

687. Moehlig, R. C., and Abbott, H. L.: Carbohydrate Metabolism in Osteoporosis and Paget's Disease, *J. Michigan M. Soc.* **45**:642-646 (May) 1946.

688. Edholm, O. G.; Howarth, S., and McMichael, J.: Heart Failure and Bone Blood Flow in Osteitis Deformans, *Clin. Sc.* **5**:249-260 (Dec.) 1945.

689. Murray, R. C.; Kirkpatrick, H. J. R., and Forrai, E.: A Case of Albright's Syndrome (Osteitis Fibrosa Disseminata), *Brit. J. Surg.* **34**:48-57 (July) 1946.

690. Patten, R. F.: Polyostotic Fibrous Dysplasia (Albright's Syndrome). *Clin. Proc. Child. Hosp.* **2**:175-184 (July) 1946.

of cases is thus 59, 39 of which are of the complete and 20 of the incomplete form. They occurred in the proportion of 3 female to 2 male patients.

Hatcher⁶⁹¹ presents a thoughtful and outstanding paper. He does not accept as bone tumors per se the localized benign fibrous lesions of bone which Jaffe and Lichenstein classified as benign tumors originating from connective tissue of matured marrow. The basis for the report is a study of 45 patients, with 51 lesions. The disorder has its inception during the period of longitudinal growth, for all but 7 of the patients were children. In all patients the lower extremities were affected, and in 5 patients more than one bone was involved. Symptoms are usually mild; in a number of cases the fibrous areas were discovered accidentally. The roentgenographic appearance of the lesion is distinctive and reveals an area of reduced density in the metaphysis close to the epiphysial disk. Later the area is apt to be elongated and is usually eccentrically placed within the bone. Sharp demarcation from surrounding normal bone by a narrow shell of bone sclerosis is usually observed. Irregular scalloped margins give the appearance of loculation. Through longitudinal growth, the defect comes to lie farther from the epiphysial cartilage, and in the process of tubulation of the metaphysis the defect may eventually occupy a part of the cortex. Surgical removal was done in 17 cases. Though the pathologic appearance varies somewhat, the basis in all stages is a fibrous connective tissue which occupies a smooth-walled, and sometimes partially loculated, cavity in the bone. The newly formed focus shows a relatively cellular fibrous tissue, with scattered multinucleated cells. In what appear to be older foci, the fibrous tissue is arranged in strands and whorls. Lipid-filled macrophages are often present and are believed to be a sign of chronicity. It was evident in the cases under observation that in many instances the lesion became obliterated spontaneously by the reparative ossification of tubulation of the bone. In the author's opinion the association of the metaphysial fibrous pockets with disorders of epiphysial bone and cartilage is too frequent to be mere coincidence. With the exception of Legg-Calvé-Perthes disease (osteochondrosis of the capital epiphysis of the femur), the incidence of fibrous defects corresponds well with the localization of epiphysial disorders. While no clue as to the primary causation of the disturbance is available, the association with demonstrable epiphysial disorders is

691: Hatcher, C. H.: Pathogenesis of Localized Fibrous Lesions in the Metaphyses of Long Bones, *Ann. Surg.* 122:1016-1030 (Dec.) 1945.

considered significant. The author believes that the association is further borne out by a similarity in course, which suggests that the fibrous lesion of the metaphysis may also follow vascular derangement.

Gaucher's Disease.—Moore⁶⁹² presents 2 cases of this rather rare condition, which is probably due to a little understood derangement of lipid metabolism. The author states the belief that splenectomy does not alter the course of the disease as regards bone, and reports that roentgen therapy failed to give relief.

Rickets.—An interesting report on nonrachitic bowlegs in childhood may be noted. Leonard and Cohen⁶⁹³ emphasize the nonrachitic nature of bowlegs occurring as a result of osteochondrosis deformans of the tibia. A unique plan of nonsurgical treatment, used in three stages, is presented for treatment of the infantile type of this condition: (1) immobilization of the limbs in plaster until the bones soften; (2) gradual correction of the deformity by wedging casts, and (3) resumption of activity, with the protection of braces until the abnormal growth process becomes static. Convincing tracings of the progress of correction in a number of cases are presented.

Infarction of Bone.—Kahlstrom and Phemister⁶⁹⁴ describe the results of autopsy in a case previously reported. The material is presented after careful and critical study; excellent photographs give gross, microscopic and roentgenoscopic details of massive lesions of both femurs and one tibia. The actual cause of the infarction was undetermined but was thought to be related to a generalized and coronary arteriosclerosis. The authors state the belief that infarcts in the condition are present much more frequently than they are found.

Since the bends (caisson disease) at times causes infarctions of bone, the report of Burkhardt and associates⁶⁹⁵ is included. They attempted to ascertain whether the use of gas, visible roentgenoscopically, might elucidate the cause of the bends. Seven susceptible subjects were repeatedly exposed to an altitude of 38,000 feet (11,600 meters), and four hundred roentgenograms were made. In only 22 instances was

692. Moore, M., Jr.: Bone Lesions in Gaucher's Disease, *Memphis M. J.* **21**:132-136 (Sept.) 1946.

693. Leonard, D. W., and Cohen, L.: Nonrachitic Bowlegs in Childhood: Osteochondrosis Deformans Tibiae, *J. Pediat.* **29**:477-484 (Oct.) 1946.

694. Kahlstrom, S. C., and Phemister, D. B.: Bone Infarcts, *Am. J. Path.* **22**:947-963 (Sept.) 1946.

695. Burkhardt, W. L., and others: A Roentgenographic Study of "Bends" and "Chokes" at Altitude, *J. Aviation Med.* **17**:462-477 (Oct.) 1946.

a roentgenographic picture characteristic of bends obtained. Pain was not related to the amount of gas found in joint cavities, bursae or vaginal sheaths. Extra-articular collections of gas were located as frequently anterior to the femur and knee joint as posterior to them. A correlation between the pain and the amount of gas, as measured on the lateral roentgenograms, was not found; pain was always present, however, when the area of gas measured exceeded 0.9 sq. in. (5.8 sq. cm.). The authors conclude that production of pain by a bubble or bubbles depends on the chance location of the bubble at a point of extra-articular tissue where nerves or nerve endings are readily distorted.

Osteosclerosis.—Kelley and Lawiah⁶⁹⁶ present 4 cases of this disease in one generation of a family. There was no evidence of the condition in the two previous generations, but 4 of 10 children were affected. The condition is of unknown cause, is familial and is characterized by an increase in the roentgenologic density of bones, with preservation of their structural contour. It is usually widespread throughout the skeletal system. Progressive anemia results from destruction of bone marrow, and the cranial nerves are injured by encroachment of bone on the foramina.

Ehlers-Danlos Syndrome.—Holt⁶⁹⁷ reports the cases of 2 sisters having this rare condition, which is ordinarily characterized by (1) hyperelasticity and fragility of the skin and blood vessels, (2) hypermobility of the joints, (3) pseudotumors over the bony prominences and (4) movable nodules beneath the skin. The roentgenograms are particularly interesting, as they reveal disseminated, small, rounded, discrete, calcareous nodules. These consist of lobules of calcified necrotic fat, surrounded by dense fibrous tissue capsules, which the author believes to be due to repeated trauma.

King-Lewis⁶⁹⁸ reports briefly 2 additional cases.

Eccentro-osteochondrodysplasia (Morquio's Disease).—This skeletal disease is characterized by (1) dwarfism, (2) deformities of the bones of the trunk and extremities and (3) roentgenologic changes, consisting of absence of ossification centers and destruction, rarefaction and proliferation of all the bones of the body, including the skull. Two phases of the disease, namely, structural defects and neurologic changes,

696. Kelley, C. H., and Lawiah, J. W.: Albers-Schoenberg Disease, a Family Survey, *Radiology* **47**:507-513 (Nov.) 1946.

697. Holt, J. F.: The Ehlers-Danlos Syndrome, *Am. J. Roentgenol.* **55**:420-423 (April) 1946.

698. King-Lewis, F. L.: Ehlers-Danlos Syndrome: Two Cases, *Proc. Roy. Soc. Med.* **39**:135 (Jan.) 1946.

are described in a report by Einhorn, Moore and Rowntree.⁶⁹⁹ They also describe the only reported autopsy in a case of this disease. An abnormal relation was noted between the first cervical segment and the skull, causing pronounced compression of the brain stem and providing an excellent explanation of the neuromuscular changes observed in the condition.

Scott and Rotondo⁷⁰⁰ report a third case in a Negro child.

Calcification.—Howard⁷⁰¹ reports 5 cases of "traumatic ossifying myositis," or ossifying hematoma. The condition in these instances followed football and soccer injuries in Naval cadets taking preflight training. The author believes that the frequency of this complication of football injuries may not be generally appreciated and suggests that roentgen therapy may be helpful in these cases.

70 Ashley Avenue (6).

XV. TUBERCULOSIS OF BONES AND JOINTS

Prepared by
ALAN DE FOREST SMITH, M.D.
NEW YORK

WILKINSON⁷⁰² discusses the relation of multiple tuberculous lesions to prognosis in the treatment of tuberculosis of bones and joints. He states the belief that associated pulmonary lesions are most important, skeletal lesions of least significance and genitourinary lesions of intermediate importance. He regards multiple infection of lymph nodes as indicating good resistance and multiple hematogenous lesions the reverse. The author feels that general benefit is gained in many cases by operation; this result may be due to removal of a source of tuberculous toxemia or to autoinoculation.

From the New York Orthopaedic Dispensary and Hospital.

699. Einhorn, N. H.; Moore, J. R., and Rowntree, L. G.: Osteochondrodysplasia Deformans (Morquio's Disease): Observations at Autopsy in One Case, *Am. J. Dis. Child.* **72**:536-544 (Nov.) 1946.

700. Scott, E. P., and Rotondo, C. C.: Chondro-Osteodystrophy (Morquio's Disease), *Arch. Pediat.* **63**:261-265 (June) 1946.

701. Howard, C.: Traumatic Ossifying Myositis, *U. S. Nav. M. Bull.* **46**:724-730 (May) 1946.

702. Wilkinson, M. C.: Treatment of Bone Tuberculosis in Relation to Multiple Tuberculous Lesions, *Proc. Roy. Soc. Med.* **39**:712-713 (Sept.) 1946.

The histories in 129 cases of skeletal tuberculosis complicated with associated tuberculous lesions, reported over a ten year period, are examined. The study shows that results in the surgical cases were slightly better than those in the nonsurgical cases, and would indicate that operation should not be withheld because of multiplicity of lesions.

[ED. NOTE (A. DeF. S.).—This evidence confirms the findings of Cleveland in a series of cases recorded at Sea View Hospital. The prognosis was affected adversely by the presence of active pulmonary tuberculosis, especially when associated with cavities and a positive sputum. However, as Wilkinson points out, some of the patients recovered, and the prognosis in this group should not be considered hopeless.]

Eriksen⁷⁰³ reports on 234 proved cases of tuberculosis of the foot and ankle, in 136 of which there were active or inactive tuberculous lesions in other organs of the body. The ankle joint was involved in 50.8 per cent of the cases, and the lesion occurred in isolated tarsal bones in 14.7 per cent. Fistulas or abscesses developed in 54 per cent of cases during the course of treatment.

Conservative measures were employed until repeated roentgenoscopic examinations revealed the tuberculous process to be at a standstill. In cases of isolated foci simple evacuation of the focus was done. Other surgical procedures were resection of joints and excision of isolated bones. There were 22 amputations. Seven patients died while the foot disorder was acute, and 19 died later, in most cases as a consequence of pulmonary tuberculosis. Drop foot developed in 18 cases, and in many the destructive processes resulted in flattening of the foot or in other deformities.

[ED. NOTE.—One wonders whether the results in these cases might not have been better if surgical treatment had not been delayed until the lesions appeared to be inactive.]

Ruppanner,⁷⁰⁴ in discussing secondary infection of tuberculous abscesses, cites a case of perforation of an abscess into the esophagus, followed by severe secondary infection, which led to erosion of the aorta, with fatal hemorrhage. He mentions 2 cases in which secondary infection of a tuberculous abscess occurred by metastasis. A young man

703. Eriksen, B.: Tuberculosis of Bones and Joints, Including Analysis of Material of Danish Disablement Pension Board of Years 1921-1940, *Acta orthop. Scandinav.* **16**:43-46, 1945.

704. Ruppanner, E.: Metastatische Infektion eines tuberkulösen Senkungsabszesses mit dem *Bacillus funduliformis*, *Schweiz. med. Wchnschr.* **75**:1089-1090 (Dec. 8) 1945.

with involvement of the third lumbar vertebra experienced a severe episode of influenza, after which bilateral iliofemoral abscesses became secondarily infected. Streptococci were demonstrated by culture. The patient died a few days after excision of the abscesses. In another case of tuberculosis of the eighth dorsal vertebra, an abscess developed in both the right and the left lumbar region. Puncture of the abscesses disclosed fetid, brownish pus and gram-negative bodies. Cultures revealed no bacterial growth. The abscess in the left lumbar region was later evacuated, and *Bacillus funduliformis* was noted in the pus. The incision failed to heal, and the patient died of severe secondary anemia.

Kisch⁷⁰⁵ reviews 253 cases of tuberculosis in which the patients were treated at the University Institute for Joint and Bone Tuberculosis, Hohenlychen, Germany, from 1920 to 1929. The author describes surgical and conservative treatment of tuberculosis of the knee joint. Since tuberculosis of joints is a metastatic process, only the metastatic lesion can be removed surgically; the patient is not so cured, cure being possible only by treatment of the entire body, resulting in healing of the primary focus. In many cases, however, conservative treatment must be supplemented by surgical measures. The author's recommended treatment includes the use of (1) weight-bearing braces (but no plaster casts); (2) traction to prevent cramps and deformities; (3) passive motion within the limits of pain, as soon as generalized pain and spasm disappear; (4) surgical measures, such as wide excision or amputation to save the life of the patient; (5) treatment of the entire body with sun and fresh air; (6) induction of local passive congestion by Bier's rubber bandage method and local roentgen therapy, and (7) aspiration of abscesses, as indicated.

In discussing his results, the author classifies the varieties of the disease as osseous, hydrops and fungous. At the time of discharge from the hospital 103 of 163 patients with the osseous type were considered cured. Sixty-two of 79 patients with the fungous type and 9 of the 12 patients with the hydrops type were cured. The follow-up results (up to eleven years) showed that 71 of 92 patients with the osseous type had healed lesions, 15 had relapsed, 3 had improved and 3 had died. In 40 of 48 patients with the fungus type and in 9 of 12 patients with the hydrops variety the disease remained healed.

[ED. NOTE.—It should be pointed out that no proof is offered of the correctness of the diagnosis in these cases and that no follow-up study

705. Kisch, E.: Treatment of Tuberculous Arthritis, *Am. Rev. Tuberc.* 53: 533-546 (June) 1946.

is detailed. The evidence accumulated over a period of thirty-five or more years on the advantages of surgical treatment is ignored.]

Herdner and Malgras⁷⁰⁶ report 2 cases of localized tuberculosis of the costotransverse joints. The standard roentgenogram did not reveal the lesions, but by serial topography arthritis of the involved joints was demonstrated. The lesions were treated by excision of the transverse apophysis and of a portion of the articulating rib with use of local anesthesia. Both patients recovered without complications.

[ED. NOTE.—At the New York Orthopaedic Dispensary and Hospital the laminagraph has proved very helpful in demonstrating obscure lesions of the bones and joints.]

Ellonen⁷⁰⁷ reports on the histologic examination of 104 pairs of palatine tonsils. Among 74 children with tuberculosis of the bones and joints or involvement of lymph nodes, tonsillar tuberculosis was demonstrated in 20 (27 per cent). In apparently healthy children tuberculous foci in hypertrophied tonsils are probably rare. If their presence is suspected, and the reaction to the tuberculin test is positive or the child is susceptible to infections they should be removed. In children with involvement of bones and joints tuberculous changes are not the primary cause of swelling of the tonsils, but children with a lymphatic diathesis are more subject to recurrent tonsillitis, and tubercle bacilli probably have more chance to propagate on the affected tissues.

The author states the belief that insufficient attention is paid to tuberculosis of the tonsils because signs of the disease in the tonsils are usually lacking.

[ED. NOTE.—Of the tonsils removed from 100 patients with tuberculosis of bones and joints, those of 25 were proved histologically to be tuberculous.]

Tuberculous Rheumatism.—Seligson⁷⁰⁸ reviews the report by Poncet and Leriche and articles by several other authors who have sought to establish tuberculous rheumatism as an entity. The observations of Poncet and Leriche have not been generally accepted in the

706. Herdner and Malgras, P.: Une localisation inédite de tuberculose ostéo-articulaire, celle de l'articulation costo-transversaire, Mém. Acad. de chir. **71**:454-457 (Nov. 28-Dec. 19) 1945.

707. Ellonen, A.: Untersuchungen über die Tonsillentuberkulose mit besonderer Berücksichtigung ihrer Beziehung zu der Knochen- und Gelenktuberkulose der Kinder, Acta oto-laryng. (supp.) **47**:1-129, 1942.

708. Seligson, F.: Poncet's Disease: Clinical Observations in Inflammatory and Degenerative Joint Reactions in Tuberculosis, Am. Rev. Tuberc. **52**:463-473 (Dec.) 1945.

United States because of too many unsupported assertions. Poncet stated the belief that tuberculous toxins caused acute rheumatism in 20 per cent of patients with tuberculosis and acute serositis in 15 per cent of those with acute tuberculous rheumatism. Chronic tuberculous rheumatism is also due to these toxins. Poncet presented as proof the simultaneous or alternating occurrence of polyarthritides and tuberculosis, the occurrence of rheumatic arthritis with a fungous tumor, similarity in cytologic features of rheumatic and tuberculous effusions, rheumatic pains after injection of tuberculin and occasionally positive reactions in guinea pig tests. Caurmont and Dor produced serous arthritis by injecting attenuated tubercle bacilli intravenously. The paper emphasizes transitory inflammatory changes in joints and serous cavities, occurring with the spread of tuberculosis elsewhere in the body. Eight cases are reported.

Sheldon⁷⁰⁹ states that tuberculous rheumatism is rare but is reported from time to time. Diagnosis may be made when rheumatic phenomena are preceded by, or accompanied with, active tuberculosis. The author refers to three clinical types described by Poncet and Leriche: arthralgia, acute rheumatism with pericarditis and chronic rheumatism. Clinically the manifestations in the joints are milder than in rheumatic fever, and there is no response to salicylates. Six cases are reported; all patients had tuberculosis, and 2 died. No attempt was made to recover acid-fast bacilli from the joints. The author concludes that tuberculous rheumatism is an expression of altered immune mechanism in a susceptible host.

Desmeules, Rousseau and Richard⁷¹⁰ review the theories and conclusions of Poncet's Lyons school and others and report 3 cases of their own. Two patients had pulmonary lesions; in 1 the lungs showed no evidence of involvement. All had multiple arthritis. In the 2 patients with pathologic involvement of the lung the tuberculous factor in the involvement of the joints was determined by elimination of other causes. Tubercle bacilli were demonstrated in fluid taken from the knee joint of the third patient.

Paraplegia in Spinal Tuberculosis.—Seddon⁷¹¹ states that early onset of paraplegia is usually caused by a tuberculous abscess. In the thoracic region, factors which favor involvement of the spinal cord are narrowness of the spinal canal; the anterior concavity of the vertebral

709. Sheldon, W.: Tuberculous Rheumatism, *Lancet* 1:119-121 (Jan. 26) 1946.

710. Desmeules, R.; Rousseau, L., and Richard P.: Rhumatisme et tuberculose, *Laval méd.* 11:35-46 (Jan.) 1946.

711. Seddon, H. J.: The Pathology of Pott's Paraplegia, *Proc. Roy. Soc. Med.* 39:723-730 (Sept.) 1946.

column, which encourages angulation at the site of disease, squeezing inflammatory products toward the cord, and the close confinement of the abscess by the anterior ligament. In rare cases the disease begins in the neural arch, compressing the cord from behind. Pathologic dislocation at the site of disease and incautious laminectomy, which may cause collapse of the spine and retropulsion of a tuberculous sequestrum, are listed as mechanical causes of paraplegia. When the onset is late in the course of the disease, the paraplegia is due not to stretching of the cord over a bony prominence, but, as Butler has pointed out, to reactivation of a small tuberculous mass inside the cord. The causal relation of tuberculous pachymeningitis to paraplegia has not been established. Acute paraplegia may occur without compression of the cord and is thought to be due to localized edema, secondary to abscess formation. A rapidly fatal tetraplegia developed in 1 case when the vertebral artery, lying in contact with an abscess, became thrombosed.

Alexander ⁷¹² discusses the surgical management of spinal tuberculosis. Skull traction is used in treatment of cervical conditions and in those affecting the upper part of the thorax. The patients are placed in anterior and posterior plaster molds, into which head traction is incorporated. While the patient is in traction, any necessary surgical procedure may be carried out. The author does not favor laminectomy in cases of typical tuberculosis of the thoracic part of the spine. With progressive neurologic deterioration in spite of immobilization, surgical drainage must be established. This is accomplished through a lateral approach with excision of the transverse processes and portions of the ribs. The pedicles are excised to reveal the lesion, and as much diseased material as is necessary to relieve pressure is removed. Thirteen patients were treated by this method; 3 died and 10 had complete neurologic recovery. The author warns against overlooking tuberculosis in patients who have symptoms of rupture of a low lumbar intervertebral disc. Two cases are mentioned.

Deery ⁷¹³ in discussing the treatment of paraplegia due to tuberculosis of the spine (Pott's paraplegia), states that it is generally agreed that 90 per cent of patients can recover through appropriate orthopedic care; the remaining 10 per cent are considered hopeless. Laminectomy as a method of treatment of this condition has been held in disrepute in the past, owing to the high mortality rate. It should

712. Alexander, G. L.: Neurological Complications of Spinal Tuberculosis. *Proc. Roy. Soc. Med.* **39**:730-734 (Sept.) 1946.

713. Deery, E. M.: Laminectomy for Pott's Paraplegia, *Ann. Surg.* **124**:201-203 (Aug.) 1946.

carry no greater risk than laminectomy for tumor of the spinal cord or for herniation of a nucleus pulposus. Laminectomy has also been criticized as mechanically weakening the back, but this should not be an objection, for the spine, if not fused by previous operation or disease, can be fused at the time the laminectomy is done.

At the New York Orthopaedic Hospital, 23 patients have had laminectomy for Pott's paraplegia. Fifteen patients showed manometric spinal block with an elevated level of protein in the cerebrospinal fluid. Six had a high protein level without block, and 1 had no lumbar puncture. Of the 23 patients, surgical fusion had been done in 15, and spontaneous fusion had developed in 1 before laminectomy. In the remaining 7 spinal fusion was performed at the time of laminectomy.

The results in 8 patients were good; the condition of 3 was improved, and that of 10 was unimproved. The follow-up period ranged from a few months to eleven years. No deaths resulted from surgical shock. There was 1 death from tuberculous meningitis and another from generalized visceral tuberculosis. These occurred several weeks after laminectomy. Of the 23 patients, 15 were adults, for 3 of whom the results were good. In 14 patients the paraplegia was of early onset. There appears to be no relation between the type of paraplegia and the result of laminectomy. The location for laminectomy was determined by the sensory level alone, but actually the positions of the sensory level, the intraspinal pathologic state and the apex of the kyphos all corresponded closely.

Pathologic Considerations.—Orell and Hellstadius⁷¹⁴ describe a case of tuberculous spondylitis in which death resulted from miliary tuberculosis. A close study of the morbid changes was made at necropsy. The investigation of these authors confirmed the observations of others that secondary anterior and posterior spondylitis usually follows a primary tuberculous process in the vertebral body. They deny that shadows appearing in the vertebral body on roentgenologic examination represent atrophy, as is maintained by some writers. The case also revealed that even extensive posterior secondary spondylitis may not be demonstrable with roentgenograms; the authors comment that this is frequently the situation in cases of centrally located foci in which the cortex is not broken. The authors state that sometimes the focus causes extensive sclerosis and osteoblastic reaction in the rest of the

714. Orell, S., and Hellstadius, A.: Interesting Case of Tuberculous Spondylitis, *Nord. med. (Hygiea)* **13**:670-673 (Feb. 28) 1942.

vertebral body and that this may help to mask a central area of tuberculous destruction.

Farina and Negri⁷¹⁵ present a case of what they term an exceedingly rare form of tuberculous spondylitis. A man aged 31 had polyperiostitis, which was quickly cured. Two years later he experienced indefinite symptoms of pulmonary disease, supposed to be tuberculous, with asthenia, anorexia, profuse sweating and emaciation, followed by lumbar fistulas, which emitted a purulent discharge. The patient died one year later. Necropsy showed spondyloperiostitis from the sixth cervical to the second lumbar vertebra, paralumbar abscesses, multiple fistulas in the lumbar region and circumscribed external pachymeningitis. No pulmonary tuberculosis was present. Histologic examination demonstrated the presence of tuberculous granulomatous tissue in the walls of the two lumbar abscesses and in the specimens from the areas of lumbar pachymeningitis. There was a subchronic inflammatory erosion of the anterior and lateral surfaces of the vertebrae and the interosseous ligaments from the sixth cervical to the first lumbar vertebra. The authors state the belief that this case is one of tuberculous spondylitis of the type described by Mandelstamm in 1933. The condition is characterized by periosteal-osteitic lesions, upward spread of the disease and a rapidly fatal course. No effective treatment is known.

Schleicher⁷¹⁶ presents data derived from autopsy material and from terminal and known cases of pulmonary and generalized miliary tuberculosis. Tuberculosis affects the bone marrow frequently enough to allow early detection of miliary tuberculosis by means of sternal aspiration and sectioning of gross units of the sternal marrow. The possibility is suggested that the procedure may be a useful tool in diagnosis and prognosis in the field of tuberculosis.

Differential Diagnosis.—Guri⁷¹⁷ discusses the problem of the differential diagnosis of pyogenic osteomyelitis of the spine with special reference to tuberculosis. He describes four clinical syndromes which may be due to the spinal lesions. There may be pain in the hip, with no clinical evidence of involvement of the hip other than limitation of

715. Farina, C., and Negri, M.: La spondilite di Mandelstamm, *Ann. ital. di chir.* **21**:567-580 (Sept.-Oct.) 1942.

716. Schleicher, E. M.: Miliary Tuberculosis of Bone Marrow, *Am. Rev. Tuberc.* **53**:115-121 (Feb.) 1946.

717. Guri, J. P.: Pyogenic Osteomyelitis of Spine: Differential Diagnosis Through Clinical and Roentgenographic Observations, *J. Bone & Joint Surg.* **28**:29-39 (Jan.) 1946.

extension of the thigh. Irritation of the intercostal nerves may suggest a localized abdominal condition. Meningeal symptoms may be due to intradural infection or to irritation of the meninges by an extradural lesion. Examination of the spinal fluid is helpful in ruling out the possibility of intradural infection. Two syndromes with pain in the back are noted: an acute form, with sudden, severe pain, in which the patient is in a toxic condition, and a subacute form, in which the condition is less toxic. A pyogenic focus elsewhere in the body may precede the pain in the back. The formation of an epidural abscess, with positive neurologic signs, may occur. If the onset is insidious, the patient may have sharp pain in the back, unrelieved by rest, and muscular spasm may be noted objectively, whereas there may be little general reaction. The author believes that the condition is probably not tuberculous when the neural arches are invaded by the infection, but states that there are no roentgenographic findings characteristic of the different types of infectious spondylitis. In the localized form of osteomyelitis an area of destruction may be surrounded by sclerosis and active bone formation. Progressive thinning of the interspace, absence of early sclerosis and minimal bone or spur formation are indicative of tuberculosis. In the diffuse pyogenic forms there are an early decrease in density and a foggy appearance of the surfaces of the bodies with early reactive bone formation and intense sclerosis. In the tuberculous forms pronounced atrophy occurs, with collapse of the vertebrae. Reactive bone formation is rare.

Lewis⁷¹⁸ describes the differential diagnosis of tuberculosis and suppurative arthritis from the point of view of the roentgenologist. His article is based on the diagnostic points set forth by Phemister in 1924. In nontuberculous pyogenic infections of the joints of the extremities, acute osteoporosis occurs, with an early decrease in the width of the joint. The earliest destruction of bone appears on the weight-bearing portion of the articular surface, and there is a tendency to repair and ankylosis. In tuberculosis there is less osteoporosis, with late persistence of the width of the joint, and the earliest destruction of bone is at the periphery of the joint. Atrophy of the muscles is usually pronounced; there is little tendency to repair or ankylosis. The author states that these factors appear not to apply to tuberculosis of the hip joint or to caries sicca. He also warns that many conditions

718. Lewis, R. W.: Differential Diagnosis of Tuberculosis in Joints of Extremities, *Rev. radiol. y fisiotherap.* **13**:115-122 and 164 (July-Aug.) 1946.

may simulate tuberculosis of joints. Several illustrative histories and roentgenograms are presented.

[ED. NOTE.—It is my experience that thinning of the joint space frequently is an early finding in cases of tuberculosis of the joint, although it does not progress so rapidly as in pyogenic infections. This change apparently is due to a trophic alteration in the hyaline cartilage, since this tissue is not directly invaded or destroyed by the tubercle bacillus.]

Ferey⁷¹⁹ and Sambron⁷¹⁹ report 2 cases of tuberculosis of the spine in which the history and findings were typical of herniation of a nucleus pulposus. A 40 year old farmer, with no history of previous illness, had felt a sudden violent pain at the base of the spine when he made a false move while unloading hay. Examination three months later revealed slight atrophy of the right leg and diminution in strength of the right achilles tendon reflex. On myelographic examination the flow of iodized oil U. S. P. (lipiodol®) was seen to have stopped at the junction of the third and the fourth lumbar vertebra. Exploration revealed a small, hard tumor anterior to the dura at the level of the third and fourth lumbar vertebrae. There was no evidence of inflammatory reaction, but the tumor contained pus. The cavity was evacuated, filled and closed with a plug of muscle. The patient made an uneventful recovery.

The second case was that of a woman aged 30, who had felt a sudden, severe pain in the lower part of the back, accompanied with a cracking sound, when she lifted a bucket of water. The pain radiated to the left leg. A myelogram taken fourteen months after injury revealed the blocking of the flow of lipiodol® at the junction of the third and the fourth lumbar vertebra. There were atrophy of the left leg and weakness of the achilles tendon reflex on the left, but no sensory disturbances. Exploration disclosed a small swelling, containing pus and caseous material, at the level of the third and fourth lumbar vertebrae. The condition was treated in the same manner as that in the first case, with complete recovery.

The authors mention an earlier case, in which operation was followed by death from tuberculous meningitis. In this case, after aspiration of the contents of the abscess, followed by curettement, they applied a thin layer of muscle instead of completely filling and plugging the cavity with muscle.

719. Ferey, D., and Sambron: Deux observations de fausses hernies discales dues à des abcès froids, *Rev. neurol.* **77**:189-192 (July-Aug.) 1945.

[ED. NOTE.—A similar case has come to my attention, in which the patient died of tuberculous meningitis after the abscess had been drained.]

Richart Sotes⁷²⁰ presents tables and gives the results of his own version of transplantation and inoculation in guinea pigs, in a report of 10 cases of suspected osteoarthritic tuberculosis. A specimen of suspected material (articular capsule or cartilage) is obtained aseptically at the time of operation and divided into three parts: one for histologic examination, one (made into a pulp) for subcutaneous injection and one for transplantation, through a buttonhole incision, into the peritoneal cavity of the guinea pig.

Tuberculosis was suspected clinically in the 10 cases, but its presence was confirmed in only 4. The method of transplantation gave positive results in all 4 cases, whereas inoculation by subcutaneous injection gave a positive result in only 1 case; histologic examination gave positive evidence in 2 cases, being of less diagnostic value than transplantation, but superior to inoculation. The author feels that his method offers a means of earlier diagnosis in cases of suspected tuberculosis. He observes that some animals died shortly after inoculation and some did not, but that in all animals caseation of the mesenteric lymph nodes occurred without affecting the serosa or becoming generalized. He offers no explanation as to why the infection takes this course.

[ED. NOTE.—Growth of tubercle bacilli on culture mediums often provides a more rapid means of diagnosis than guinea pig inoculation and is worthy of addition to the routine methods.]

Antibiotics.—Frank⁷²¹ expresses the opinion that local injection of penicillin into the fistulous tract is of distinct advantage in bringing about a permanent closure of most tuberculous fistulas with secondary infection, provided (1) the tuberculous process is no longer active, (2) the sequestrums are all removed and (3) the invading organisms are sensitive to penicillin. The author instilled penicillin into the sinus tracts twice daily, injecting under a fair degree of pressure in order to make the drug penetrate to the deepest portion of the fistula. The author states that systemic treatment with penicillin is indicated in cases of extensive fistula formation with toxic symptoms, poor

720. Richart Sotes, T.: Contribución al diagnóstico diferencial de la tuberculosis osteoarticular, *Rev. españ. de tuberc.* **15**:261-274 (April) 1946.

721. Frank, P.: Penicillin Therapy of Secondary Infected Abscesses, *Nederl. tijdschr. v. geneesk.* **90**:366-367 (April 27) 1946.

general condition of the patient and beginning amyloidosis. He further states the belief that caseous masses or poorly nourished granulation tissue in the depths of wounds should be removed before the local treatment is begun.

Four cases are presented; in 3 the fistulas closed completely in from one to four months of treatment. In the fourth case, the infection, caused by *Escherichia coli*, did not respond to penicillin therapy.

Lapierre ⁷²² presents 4 cases of multiple tuberculous fistulas with secondary infection. The ages of the patients ranged from 3 to 28 years. In 3 cases lesions involving the hip and in 1 a lesion of the knee were treated by débridement of the fistulous tracts and by administration of penicillin, both locally and systemically. Laboratory tests showed gram-negative cocci, *Staphylococcus albus* and *Staphylococcus aureus* in all 4 cases; in only 1 case was *Mycobacterium tuberculosis* demonstrated. From the clinical course and manifestations, the condition in all 4 cases was thought to be undoubtedly of tuberculous origin. All patients were in poor general condition. Improvement was noted one week to ten days after the beginning of treatment; after the course of penicillin therapy, in which total amounts of the drug varied from 1,175,000 to 5,160,000 units, all fistulas had either closed or almost closed, with little residual discharge.

The author describes the surgical and the conservative treatment of tuberculous wounds in the orthopedic cases in the Sacré-Coeur Hospital in Montreal. When surgical procedures are planned, penicillin is given preoperatively for two or three days. The abscesses or fistulas are débrided widely and closed over rubber tubes, for use in lavage and local instillation of penicillin. Local and intramuscular administration of penicillin is continued for at least ten to twenty days after the disappearance of the agents of secondary infection. Laboratory examination of the pus is made at regular intervals.

The conservative method is used when there are too many fistulas for débridement and in cases of large atonic wounds. For such wounds the surrounding skin is washed daily with medicinal soft soap U. S. P., cleansed with ether or benzene, swabbed with a 70 per cent solution of alcohol and covered with a large dressing. Penicillin is given intramuscularly. After the secondary infection has been overcome, regeneration is encouraged with a commercial pomade called herisan,⁵ which contains halibut liver oil, boric acid, talc, zinc peroxide and sulfathiazole.

⁷²² Lapierre, V.: Therapy of Secondary Infected Fistulas, with Special Reference to Penicillin, *Union méd. du Canada* 75:799-784 (July) 1946.

[ED. NOTE.—Streptomycin has been remarkably successful in promoting the closure of tuberculous sinuses, presumably because of its effect on the tubercle bacilli. Possibly a combination of streptomycin and penicillin would offer the best treatment of this condition.]

Morgan and Bosworth⁷²³ report the case of a 35 year old physician who had tuberculosis of the lung, the cervical and dorsal portions of the spine and the ilium, with draining sinuses in the neck. Treatment consisted of transfusions, the administration of 32,000,000 units of penicillin and spinal fusion, performed in two stages, from the occiput to the tenth thoracic vertebra. At this point a paraspinal abscess ruptured through the pleura and lung into the bronchial tree, and the patient's condition became critical. Streptomycin was given as a last resort, 4,000,000 units being administered over a period of twenty-four hours. The dose was then maintained at 1,000,000 units daily for fifty days. At the end of that time, the patient's general condition was greatly improved. The sinuses in the neck, which had been draining for thirteen months, closed in twenty-one days. The temperature became normal; the sedimentation rate fell to within normal limits; the sputum became negative for tubercle bacilli; coughing and raising of sputum ceased, and infiltration of the chest cleared. The author states the opinion that recovery in this case can be attributed to the administration of streptomycin.

Keefer and others,⁷²⁴ in an article on streptomycin in the treatment in 1,000 cases of infection, mention 4 cases of tuberculosis of bones and joints, in 2 of which improvement was noted.

Operative Procedures in Tuberculosis of Bones and Joints.—Resection of the knee was performed by Stanischeff⁷²⁵ on 53 patients who had had tuberculosis of the knee joint for an average period of eight years. Most of the patients had been treated by conservative methods for years before coming to him and had fibrous and osteofibrous ankylosis in flexion or, more rarely, in recurvation, with or without subluxation of the joint. One third of the patients had sequestrums and fistulas.

The treatment consisted of complete resection of the joint, including the patella and capsule. Any sequestrum was removed, the wound

723. Morgan, C., and Bosworth, D. S.: Transpleural Rupture of Tuberculous Spinal Abscess Treated Successfully by Streptomycin: Report of Case, *J. Bone & Joint Surg.* **28**:864-868 (Oct.) 1946.

724. Keefer, C. S.; Blake, F. G.; Lockwood, J. S.; Long, P. H.; Marshall, E. K., and Wood, W. B., Jr.: Streptomycin in the Treatment of Infections, *J. A. M. A.* **132**:4-11 (Sept.) 1946.

725. Stanischeff, A.: Knee-Resection of Joint, *Minerva med.* **1**:25-28 (Jan. 6) 1942.

closed and a plaster cast applied. In 42 of the 53 patients no sinuses remained after operation, and walking on the limb was satisfactory and painless.

[ED. NOTE.—My experience has been that attempts to eradicate the diseased tissue as completely as possible, by radical excision of the joint, are unnecessary and cause needless mutilation. The majority of patients recover after simple arthrodesis with minimal resection of bone.]

Servelle ⁷²⁶ discusses an operation for tuberculosis of the shoulder, used first by Leriche during World War I in the treatment of wounds and applied in the treatment of tuberculosis in 1930. The operation is described in detail; its chief features are meticulous excision of the fungous lesions, cauterization and curettage if necessary, and the filling of the cavity with osteoperiosteal grafts, obtained previously from the tibia. Leriche used this method in 20 cases of humeroglenoid tuberculosis in adolescents and adults. All the operative wounds healed by first intention, and in all cases ankylosis occurred rapidly. Follow-up examinations at one, two and seven years showed cure in all but 1 case, and fusion was obtained in this case after a second operation. The author states that ankylosis is obtained in two to three months by this method.

Freiberg ⁷²⁷ performed several Brittain ischiofemoral arthrodeses over a period of seven months in 1944; he then waited six months to determine the results in these cases, prior to repeating the procedure. Although numerous additional operations were done, studies of end results are reported only in the first 7 cases. The follow-up period was thirteen to twenty months. Six patients, from 7 to 18 years of age, had tuberculosis of the hip; the seventh patient had degenerative arthritis. In 4 of the 6 patients with tuberculous hip, osseous fusion (determined clinically and roentgenographically) resulted within seven to nine months; in 1 patient, a 7 year old girl who broke the spica several times after operation, firm fibrous union developed. She was ambulatory and asymptomatic sixteen months after operation. Renal tuberculosis developed in a 72 year old woman one month after operation, necessitating removal of the spica for nephrectomy. One year after the Brittain fusion, her hip had minimal motion clinically, and

726. Servelle: De la résection de l'épaule pour tuberculose par le procédé de Leriche, *Rev. d'orthop.* 32:189-193 (May-Aug.) 1946.

727. Freiberg, J. A.: Brittain Ischiofemoral Arthrodesis, *J. Bone & Joint Surg.* 28:501-512 (July) 1946.

roentgenograms indicated apparent healing. The 1 nontuberculous patient showed clinical and roentgenographic fusion within four months.

In tuberculous patients surgical procedures have not been carried out in the presence of active abscesses. Contraindications to this operation exist in those few instances in which diseased bone cannot be "short-circuited" by the osteotomy and grafting.

Bosworth and Green⁷²⁸ report on fusion of the hip in 32 cases of unilateral tuberculous infection of the hip joint. Four types of surgical procedures were used: (1) the standard Hibbs technic; (2) massive transplantation of the anterior portion of the crest of the ilium, across the joint line; (3) packing with bone chips after curettage, and (4) simple curettage of the joint. Fusion was achieved in 80 per cent of cases after the Hibbs type of graft, in 70 per cent after massive inlay grafting and in 50 per cent after curettage and the addition of chips; in 1 acute case, in which treatment was by curettage, union did not take place. The average time required for solid union after the Hibbs procedure was twelve months; after massive inlay grafting it was eighteen months.

Karken⁷²⁹ states that fusion of the hip in patients with tuberculosis should not be attempted before the age of 8 to 12 years because the greater trochanter is not sufficiently ossified before that time and deformities may develop. Successful fusion does not necessarily effect cure of the tuberculous process, but the chance for the disease to remain arrested is better in the fused hip than in one that has a little mobility. An opening into a tuberculous focus does not constitute an obstacle to primary union, but sinuses are more likely to develop if the process is exposed. The type of fusion should fit the case. If a short time has elapsed since the active phase of the disease, a para-articular arthrodesis is indicated because of the better chance of avoiding the infected area. Fusion should be done in the phase of recovery, three to six years after the onset; sinuses and fistulas develop more frequently when the operation is done too early. Immobilization should be continued until roentgenograms show that the graft has thickened and is recalcifying; this process usually requires six to seven months after operation. Karken analyzes fusion of the hip in 23 cases of tuberculosis.

1 East Sixty-Third Street (21).

728. Bosworth, D. M., and Green, L. A.: *Experiences with Arthrodesis for Tuberculosis of Hip*, *Quart. Bull., Sea View Hosp.* 8:39-46 (Jan.) 1946.

729. Karken, A.: *Arthrodesis in Treatment of Tuberculous Coxitis Sequelae*. *Acta orthop. Scandinav.* 16:1-27, 1945.

XVI. INFANTILE PARALYSIS

Prepared by

C. E. IRWIN, M.D.

WARM SPRINGS, GA.

ARMSTRONG⁷³⁰ states the opinion that paralysis of an extremity beginning at an early age frequently results in disturbance of bone growth. Several experimental studies on dogs are mentioned; in these it was indicated that with growth the bone of a paralyzed limb continues to gain in mass, but at a rate lower than normal. He cites several experiments by other investigators, using rats and dogs in which the brachial plexus had been severed. Shortening of bone and atrophy occurred in all the experimental animals, to varied degrees. Armstrong's own experiment on large rats, also performed after the brachial plexus had been severed, indicated that (1) the growth in length of the radius was affected earlier, and to a greater degree, than that of the humerus; (2) the reduction of growth in diameter of the humerus was greater than the reduction of growth in length; (3) the growth in diameter of bone was reduced, but not prevented; (4) the quantity of bone and bone salt was reduced 25 per cent, and (5) the humerus, but not the radius, of both normal and paralyzed limbs of rats 132 days old practically ceased to grow in length. The author thus concludes that paralysis of a limb interferes more with appositional than with epiphysial growth, and that growth of bone is not completely prevented in a denervated limb.

Bayley⁷³¹ presents a method and subject data for predicting adult height, using data from skeletal roentgenograms and the height of the subject at the time of examination. Chronologic age must be considered when the growth of a child in the younger age group is retarded or accelerated in a considerable degree. Mention is made of the work published by Gill and Abbott, who used percentile groups according to heights at successive ages and predicted adult height from skeletal age, disregarding chronologic age if a child was retarded or accelerated more than 6 months in skeletal age. The data presented are valuable when used with roentgenograms showing ossification centers of the hand and roentgenographic evidence of other centers which

From the Georgia Warm Springs Foundation.

730. Armstrong, W. D.: Bone Growth in Paralyzed Limbs. *Proc. Soc. Exper. Biol. & Med.* **61**:358-362 (April) 1946.

731. Bayley, N.: Tables for Predicting Adult Height from Skeletal Age and Present Height. *J. Pediat.* **28**:40-64 (Jan.) 1946.

have been assigned skeletal ages in predicting the adult height of children whose growth is incomplete.

Teleroentgenography, though allowing accurate records of comparative length, produces an increasing degree of magnification and distortion as the extremities grow. A method designated as orthoroentgenography is described⁷³²; this allows a single roentgenographic film (14 by 42 inches, or 35 by 105 cm.) to be used with three exposures in sequence, the central ray being directed successively over each of the three joints. The results of this method satisfy the following requirements, set up by the Harvard Infantile Paralysis Commission:

1. Measurement of bones should be sufficiently accurate that comparative true lengths may be recorded at any one examination.

2. The precision of measurement should remain constant for varying bone lengths in order that the true increments of growth may be computed accurately.

3. Sufficient detail should be delineated to allow detection of abnormalities in the bones and visualization of the epiphysial lines.

Hodgen and Frantz⁷³³ present a summary of the various technics for epiphysial arrest, discuss the calculation of the optimum time for the arrest, give a table of growth expectancies and describe the methods of roentgenologic determination of leg lengths. They present the technic of the operation, a modification of the Phemister technic, using either the bone block-turning method or the Blount method, with chrome nickel stainless steel staples. An analysis of 21 cases in which arrests were performed after the method of Phemister showed good results in 48 per cent, fair results in 47 per cent and poor results in 5 per cent.

A survey of the literature on epiphysial arrest for equalization of leg length is presented,⁷³⁴ with reports of deformities resulting from epiphysiodesis of the femur, the fibula and the upper end of the tibia. The authors add reports of 4 cases of deformities about the knees, 3 cases of genu valgum and 1 case of genu varum, in all of which the condition developed from two months to two and one-half years after arrest of the lower femoral and the upper tibial and fibular epiphyses. In 3 cases the deformities about the knee were sufficiently

732. Green, W. T.; Wyatt, G. M., and Anderson, M.: Orthoroentgenography as Method of Measuring Bones of Lower Extremities, *J. Bone & Joint Surg.* **28**:60-65 (Jan.) 1946.

733. Hodgen, J. T., and Frantz, C. H.: Arrest of Growth of Epiphyses, *Arch. Surg.* **53**:664-674 (Dec.) 1946.

734. Regan, J. M., and Chatterton, C. C.: Deformities Following Surgical Epiphysial Arrest, *J. Bone & Joint Surg.* **28**:265-272 (April) 1946.

severe to necessitate wedge-shaped osteotomies of either the upper part of the tibia or the lower part of the femur. In all the cases the deformities could be attributed to the failure of part of an epiphysis to fuse after operation for epiphysial arrest.

The basis of a paper by Fancher⁷³⁵ is the experimental treatment with glandular extracts of 67 adolescent patients who were growing too rapidly. Testosterone propionate U. S. P., diethylstilbestrol U. S. P., thyroid U. S. P., calcium compounds, vitamin D and various extracts of ovary and testis were used over a period of fifteen years. (The author's own previous experimental work had shown that a sufficiently high dose of androgens or estrogens will inhibit skeletal growth in the rat.) The diagnosis in all cases was hyperpituitarism (anterior lobe). Fifty-two of the 67 patients showed an inhibition of growth (6 of these were not growing at all); the other 15 either showed no decrease or had accelerated growth as a result of the treatment. The average time of treatment was eighteen months. Treatment continued until closure of the epiphyses, when possible.

No serious ill effects were encountered. Fancher concludes that the evidence indicates that too rapid growth in children may be safely retarded with diethylstilbestrol U. S. P. or estradiol benzoate U. S. P., with the addition of calcium and vitamin D.

Napier⁷³⁶ presents a splint which is designed both to maintain the thumb in a position of function when there is weakness of the thenar muscles and, at the same time, to exercise the antagonists. Essentially, the device consists of a pad placed between the thumb and the index finger and three leather rings, one each around the thumb, the index finger and the little finger. Elastic is used for traction.

[ED. NOTE (C. E. I.).—Photographs shows the thumb in abduction, but not rotated internally or pulled sufficiently far across the palm. The fifth finger has a tendency to flex and abduct before the thumb moves.]

Olmos⁷³⁷ describes the creation of an anterior bone block in the ankle, according to the technic of Putti, to correct deformity of the calcaneus after paralysis of the triceps surae muscle in cases of poliomyelitis. He states that many pathologic phenomena occur after paralysis of the gastrocnemius and soleus muscles. There are loss of plantar flexion, progressive elongation of the triceps surae, loss of balance between the plantar muscles and the posterior calf muscles,

735. Fancher, J. K.: Control of Stature, *J. M. A. Georgia* **35**:27-33 (Feb.) 1946.

736. Napier, J. R.: Corrective Splint for Paralysis of Thenar Muscles, *Brit. M. J.* **1**:15 (Jan. 5) 1946.

737. Olmos, V. S.: Treatment of Paralytic Calcaneus, *J. Bone & Joint Surg.* **28**:780-786 (Oct.) 1946.

increase in the talocalcaneal angle to values above 50 to 55 degrees and structural and trophic changes in the talus, the os calcis and the investing soft tissues. There also develops, depending on the power of the remaining musculature, either cavus, when the peroneal muscles are paralyzed, or flatfoot, when the anterior and posterior tibial muscles are no longer functional. Since the power of the triceps is approximately three times the power of the muscles of dorsiflexion, tendon transplantation cannot be expected to prevent the deformity.

The operative procedure consists of a bone block built up on the neck of the talus, using cancellous bone obtained while performing the subtalar arthrodesis; the foot is then immobilized for three months in plaster, in the position of talipes equinus. The author reports good results in approximately 76 per cent of 67 cases followed for more than one year.

[ED. NOTE.—Olmos does not state at what age bone operations were done on children. No mention of plantar fasciotomy is made; this procedure is necessary in the majority of cases of true deformity of the calcaneus. When good musculature is available for transplantation to the calcaneus, the anterior bone block is not necessary. In patients with weak musculature a dangle foot is present, and fusion of the ankle should be considered if there is enough strength about the knee to remove the brace.]

CORRECTION

In the article by Drs. Smathers and Weed entitled "Treatment of Tetanus," in the September issue (ARCH. SURG. 57:291, 1948), "mg." was used in several places instead of "units." This error appeared in the section on "D-Tubocurarine in Wax and Oil" on pages 295, 296 and 297.

MORE HUMAN ATTITUDES IN SURGICAL PRACTICE

Presidential Address

HARRY B. ZIMMERMANN, M.D.

ST. PAUL

PSYCHOLOGISTS tell us that there is no such thing as a mentally absolutely normal human being, that some of us tend toward aberrations paranoid in type and that some of us are a trifle schizoid. I must admit, after thinking over what I am going to present today, that I belong to the latter group. So I hope you will bear with me and try to realize that the things I say are abstract generalizations and that you will not take the attitude of the wife who once asked her husband why women were always excluded from males in after-dinner conversation. He told her that the discussions were usually more or less controversial, but definitely dispassionate, and that women tend to take abstract criticism personally and immediately become defensive. Her response to this was, "But, John, I'm not like that, am I?"

The Preamble of the Constitution of the Western Surgical Association reads, in Article 2: "The object of the Association shall be the cultivation, promotion and diffusion of the knowledge of the art and science of surgery; to sponsor and maintain the highest standards of practice."

There is no doubt that we have accomplished great things and filled the obligations of the first portion of this Preamble beyond the fondest dreams of the founders of the organization. In going over the *Transactions of the Western Surgical Association*, one will be struck by the fact that a great deal of the development of the art and science of surgery has been accomplished by our members and that at each meeting surgical diseases have been studied from the viewpoints of pathogenesis and pathology and expedient technical procedures for their alleviation and cure have been elaborated and discussed.

But have we done so well, or spent enough of our effort, on the last phrase of the preamble—"to sponsor and maintain the highest standards of practice"? No one can doubt that the Western Surgical Association has maintained the highest of surgical practice, but that we have made any active or vigorous effort to sponsor or assume any leadership (except by our own examples) in developing the highest

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type of surgical practice for the good of the community or gone out of our way, appreciably, to make available to the communities in which we live the highest type of surgical practice is open to question.

This discussion was motivated by a series of articles, both in lay magazines and in medical journals, criticizing surgeons for doing unnecessary and ill advised operations. An article in the *Woman's Home Companion* in July 1948 began with the statement: "Medical men have long known the shocking fact that many of the nine million surgical operations performed annually in America are unnecessary. Among doctors it is an open secret that in many an operating room the cloak of surgery covers mayhem and even manslaughter." In this same article a well known gynecologist is quoted from an article in the *American Journal of Obstetrics and Gynecology* under the title "Hysterectomy: Therapeutic Necessity or Surgical Racket?" He analyzed 246 operations in which the uterus was removed and in which 30 per cent of the removed uteri were absolutely normal. Also in this article was a quotation on the same subject from an editorial in *The Journal of the American Medical Association*.

In a recent number of the *Reader's Digest* a story was epitomized from *The Modern Hospital* entitled, "The Truth About Fee Splitting." Again, in the October issue of the *Woman's Home Companion* there was a story, read by thousands of our citizens, lamenting the predicament of the thoroughly qualified young surgeon who has had five years resident training, is entirely qualified to do any kind of surgery and whose talents are denied society because he cannot obtain hospital facilities absolutely essential to do his work, and this because of the selfishness of less competent older surgeons.

Society recognizes that scientifically and technically we have accomplished much and considers our services indispensable. It is genuinely appreciative of our accomplishments, as evidenced by the fact that there has never been a time in history when the medical and surgical professions have been more abundantly rewarded, not only by generous individual remuneration but also by vast contributions for medical education, graduate study, almost extravagant hospital facilities and huge funds for research. In other words, the criticism in lay periodicals accuses us solely of not living up to our traditional reputation for altruism and devotion to the service of mankind.

Let us, then, take these various accusations specifically. Are we doing unnecessary and ill advised operations? In editorials on this subject in our own journals we have already pleaded guilty. Such a plea precludes any defense, but we should make an effort to correct this situation.

This is not so easy, because there are many conditions which have brought it about. Broadly speaking, it seems to me that these may be put into three classes: first, plain dishonesty, avarice and cupidity among a small proportion of the members of our profession; second, ignorance of therapeutic procedures other than surgical ones and, third, too great a zeal for technical surgical achievement.

With regard to the first, we will always have members of the profession who will find it difficult to live up to its ideals, but at least we can improve the situation by maintaining our ideals and accentuating their importance. They are the oldest traditions of the medical profession, and from time immemorial it was considered important to indoctrinate the candidate for medical practice with a certain moral code and a proper appreciation of his obligation to society. The apparent lack of ethical sense can only be obviated by (1) selecting more carefully candidates for medical school, (2) seeing to it that they have an opportunity for a broader cultural and humane education and (3) indoctrinating them, all during their training, with proper ethical values.

Better selection of the types of persons admitted to medical schools is difficult because medical faculties do not select their students. Candidates for medical schools make up their minds they want to become physicians, or their parents make up their minds for them. Very often, and properly, medicine is selected as a career for a young man in order that he may improve his social and economic status. This is a laudable motive; equal opportunity is the greatest blessing of a real democracy, and opportunity to achieve social betterment should be denied no one. But the person who goes into medicine solely to improve his social and economic status will more than likely accomplish that sole objective.

There is probably no one less competent to appraise the aptitudes of a youngster for the profession of medicine than are his parents. All of you have had a fond mother tell you that little Willie is to be a surgeon and that she knows he will be a success, because he has always loved to pull things apart, especially bugs and grasshoppers, and that now he is in high school he is just fascinated with the business of cutting up cats. But his brother Jim just never could be a doctor—he is much too sensitive. He never could bear to hurt things. So he is going to be a minister, a servant of the Lord.

I feel like asking such a mother if little Willie had ever expressed a desire to become a pirate or a bandit and, if he had, telling her she would make a great mistake in trying to thwart this very natural ambition! As for Jimmy, would she please suggest to him that many

of our greatest surgeons selected their professions purely as a means of serving the Lord?

In order that there may be some opportunity for the medical faculty to take part in the selection of their students, I think it is important that we go back to an academic requirement of from three to four years and discontinue the "pre-medical" school. Up to a few years ago it was required that a medical student have this period of academic or cultural training; now this has, to all intents and purposes, been entirely eliminated. Young men are admitted from high school to what is termed "pre-med." In this two year premedical course they are intensively taught the basic sciences related to medicine; any cultural training they get during this time is purely incidental. The assumption today is that when a young man enters premedical school he is already a candidate for his medical degree and, unless he is expelled or fails, he will receive it. Should he fail before the end of his second year, so far as he is concerned the two years will have been wasted.

Substituted for this premedical education should be a general education of from three to four years in the liberal arts college. Here the student should begin a system of ethical indoctrination. It is at this stage that the various psychologic aptitude tests might be applied, as well as tests to discover important intellectual deficiencies. For instance, there would be many candidates who would be found to be functional illiterates, having not yet learned to read with speed and comprehension. Others, because of the great variation in home cultural backgrounds, might be handicapped, and they should be given special opportunities. Colleges preparing students for medical school should have available an adequate staff of carefully selected, mature advisers—not young men, candidates for doctors' degrees in limited fields, or recent recipients of such degrees, but mature, well educated persons qualified to appraise the shortcomings and talents of students and to advise them properly as to courses that would best develop them. With the present overcrowding of our educational institutions, it might be difficult to find enough such personnel, but I think it would be feasible to recruit advisers from outside the university as volunteers and train them for their jobs. Their function would be to select courses to overcome the aforementioned deficiencies.

There was a time when medicine, law and theology were considered learned professions. These professions were taught in universities and were honored with doctors' degrees. The secondary school preparation for them was in the classical humanistic tradition, in this country by the latin school, in England the public school, in France the lycée and in central Europe the *Gymnasium*. When technical skills became essen-

tial to society, the polytechnic schools were established. These schools differed from universities in that graduates usually did not receive doctors' degrees. Their function was to train experts in chemistry, engineering, agriculture, military science and various other technical skills. The *Realschule* was the preparatory school for the polytechnic institute; it was a sort of revolt against classical humanism. It taught the essential humanities, but mathematics and the natural sciences were emphasized. There is no doubt that classical humanism came to be a type of intellectual snobbery that we have properly outgrown, but I feel that today we are making a fetish of educational realism. When a degree of doctor of medicine is merely a license to practice a service trade along with druggists, optometrists, masseurs and so forth, we should not be shocked if its recipients have big business or craft guild objectives.

One thing which is extremely important is that teachers and advisers, as well as medical students themselves, be oriented as to the importance of science. It is necessary that they get over the notion that physicians, and especially surgeons, are scientists. It is vital that all medical men have a thoroughly competent scientific background; science is basic to the understanding of a physician's profession. A little boy once defined salt as "the stuff that makes potatoes no good when you don't put it on." Philosophy and the humanities are the salt for science. A great scientist, and one of the foremost biochemists of today, President Conant of Harvard, points out how rarely in our daily lives we are influenced by the results of modern science but how often we reflect in our acts the philosophy and poetry we have imbibed over many years. "A dictator," he says, "wishing to mold the thoughts and actions of a literate people could afford to leave the scientists and scholars alone, but he must win over to his side, or destroy, the philosophers, the writers, and the artists."

I am using the term science in its generally accepted connotation: knowledge that lends itself to a strictly quantitative formulation. But there are two adjectives commonly used to designate intellectual values, always in a negative or exclusive sense: first, "scientific," having a kind of myopic acquaintance with laboratory method, and, second, "practical," a sort of empiric approach that gets by without much of any knowledge. Neither of these exclusive qualities is in the least critical for the selection of candidates for the practice of medicine.

Scientists must have great information, and they must know how to apply it—which is knowledge. This information must be accurate; it need not necessarily be adequate in the sense that it should be for the surgeon. The surgeon must be wise, and I use the word wise advisedly. Webster's definition is "discerning, and judging soundly

concerning what is true or false, proper or improper; choosing the best ends and the best means for accomplishing them."

To make a physician's knowledge adequate, he must have comprehension of those things inspiring human action; he must have had, some time in his life, the benefit of contact with, and observation on, the motives and stimuli of man's behavior. He needs to acquaint himself with all aspects of human nature. The surgeon who has been trained to recognize that his patients are human beings and have lives beyond the operating table will not conclude his efforts without reflecting on the effects of these efforts on the lives of his patients. His knowledge is inadequate, and he is not wise, if he ignores the emotional differences of men. Scientists are not required to emphasize this point, but surgeons are. Persons who are preparing for medicine or surgery and who will have to deal with the destinies of human beings must have humane knowledge. Their education must be liberal, humanistic and man centered.

The academic training for medicine should not be intended to make successful contestants for radio quiz programs by filling the student with all sorts of information. Our students need information, they need knowledge more and they need wisdom most of all. They should have a sufficient knowledge of such subjects as history of science, history of ideas and those manifestations of human emotions such as religion, literature and the arts, sufficient of philosophic method to give them assistance in knowing the nature of proof, the criteria of valid judgment, the relation of knowledge and action, the difference between infantile and sophisticated thinking and other information tangential to the making of adequate judgments.

It is all important for a physician to be able to pass sound judgment, to evaluate adequately and to know with reasonable certainty how to make the ever finer distinctions and to do all this humanely. Yes, we need information, but we need knowledge and wisdom most of all. The selection of young persons competent to study medicine is essential for the future of our profession. Three to four years of college training is extremely important—important for the student in that it gives him an opportunity to acquire values necessary for the study and, later, the practice of medicine and important for the medical faculty in that it gives them an opportunity to make aptitude and personality inventories necessary for the selection of students who should be encouraged to take up medicine as a profession.

As an illustration of what I mean by ethical indoctrination, this story was told me by a professional educator, one time President of St. John's College in Annapolis, Md. Being at Annapolis, he was familiar with the training methods at the naval academy. He had

observed the rigid, severe discipline, the incisive and monosyllabic answers given to questions by the neophyte. All this, he understood, was to train the young cadet in unquestioned obedience. On a visit to England he had an opportunity to look over a British naval academy. There he found little of this formal discipline. The students did not march in military formation to and from classes, and they were relaxed and at ease but behaved like gentlemen at all times. He learned that the British midshipman began his training much earlier than the American one, and during his entire academic life, along with his technical training, he was actually brought up on the heroic poetry and stories of England and especially of the navy. From this type of literature he became so imbued with the heroic traditions of the British navy that his loyalty and obedience would never be questioned.

As to the medical school itself, there has never been a time when medicine was as competently taught as it is today in our accepted medical schools, but there are some phases of the teaching that could be improved on. There is a tendency on the part of the medical faculty to treat undergraduate medical education as a preparatory training that would be more or less valueless if it were not supplemented by two to five years of graduate work. In the four years at medical school the student should be taught all branches of medicine, with emphasis on the various clinical studies in proportion to their importance for a good general practitioner. The student should never be allowed to lose sight of the fact that he is being trained to be a physician and that his first duty is to his patient.

The importance of the various clinical studies is a matter for the faculty to decide. Because the student has decided early in his career that he intends to become a specialist, he should not be allowed to neglect certain fields because *he* feels that they are unimportant to him. If we are to expect a proper and unprejudiced attitude on the part of the student, that attitude must be most scrupulously manifested by the clinical teacher. He should accept the fact that medicine is one and that the basic principles underlying its teaching are the same for all clinical fields. It must be definitely understood that specialization should be inclusive and not exclusive; if one acquires special knowledge or skill in some field of medicine it should be in addition to, not at the expense of, basic knowledge of medicine. It is not only expedient, but proper, that the various clinical subjects and therapeutic skills be taught by specialists, but it is poor pedagogics to overemphasize one field to the disparagement of others. This attitude on the part of a teacher will confuse the student and spoil his concept of oneness in medicine.

As for the intern year, this could be one of the most important periods in the education of a physician. The intern is in the most impressionable stage of his medical life; he is an abject hero worshiper. Not only do we take no advantage of this character to develop the best that is in the intern, but we neglect and discourage any spark of idealism he may have previously acquired.

Assume that a young graduate in medicine, possessing air castles built of the best ideals on a foundation of altruistic ambitions, has received an appointment as an intern in a teaching hospital. His hope is that now he will come to know the men he has listened to from the benches in the amphitheater. He asks for nothing more than to be a disciple of these great men for a year, to learn their clinical methods, to study patients and to be able to submit the results of his studies to the master for his approval, and should he occasionally receive a word of commendation, his ego will be built up exceedingly. But this is not what happens. He is almost never allowed to speak either to the professor or to the patient, he receives orders from a third assistant resident, written on slips of paper or over the house telephone, to pass a catheter or a stomach tube, insert a needle in a vein or deliver some material to the laboratory for analysis. He is on what is known as a "straight service." If this is a surgical service, he may hold a retractor during an operation. He may even be allowed to do a small operation under the direction of the resident. What a perverted idea such a young man gets of the practice of surgery. He receives no intellectual stimulus. His entire internship is spent in a series of mechanical doings. He passes tubes, he inserts catheters, he works in the operating room holding retractors; later on he is rewarded by being allowed to do some small operation. This entire experience is not only uninspiring but disillusioning and heartbreaking. Should this young man be one of the eighty or ninety in a hundred who will have to go out into the world to practice, with no further clinical knowledge of the practice of medicine and a most perverted notion of surgery, is it any wonder that he may lose some of his ideals? Should he have received his internship in a private hospital, he might at least have had a varied and more adequate clinical experience, but if we are to take as factual the statement in the *Woman's Home Companion* that "thirty per cent of all operations are done for the benefit of the surgeon only," then this training certainly will not conduce to the best in medical practice by him.

It will be a long time before we can develop any standard for graduate surgical training. It is a question whether too much standardization is to be desired. If one realizes that graduate training in special fields is new in this country, it must be admitted that we are doing remarkably well.

I said earlier in this paper that I felt that ignorance of therapeutic methods other than surgical ones was responsible for a great deal of ill advised operations. None of us enjoy being regarded as pure craftsmen who perform mechanical operations according to the prescription of physicians; we resent having surgical therapy prescribed as is physical therapy or the compounding of medicines; we contend that we are physicians, able to make or verify diagnoses and to evaluate the indications for surgical therapy. This attitude on the part of the surgeon would be right and reasonable if his premise were true. There are practically no diseases today wherein surgical treatment is never indicated, and if the surgeon assumes competence for making his own diagnoses, he must be trained to have this competence. If he expects recognition for being able to evaluate the advantages of surgical treatment over other methods, he should know, unprejudicially, the possibilities and value, if not necessarily the technics, of all other treatments. This should be the attitude in all fields of special therapy, and with this concept we should indoctrinate the graduate student. I sometimes feel that we give students the impression that nonsurgical treatment, if not purely palliative, at least is not permanent—that there is a finality only in ablative surgery. If by that we mean that, once done, ablative surgery cannot be undone, this is true.

The teaching attitude in some of the larger cancer centers in Europe, and in one or two in this country, appeals to me. The resident serves in all the therapeutic departments of the institution and becomes sufficiently expert in all forms of therapy, so that, without prejudice, he can use with wisdom any form of treatment to the best advantage of the patient. I feel that we should have frequent conferences of all the special groups, physicians and surgeons, to study diseases and their treatment in which we all might have an interest.

There is no reason today why we must perpetuate the medieval, academic feud between physician and surgeon. In the graduate training for both medicine and surgery, cooperation between the physician and the surgeon and the psychiatrist is not enough; there should be more actual collaboration. In any hospital with which I am associated we do not even have any consultations with other departments. The *modus operandi* is this: The physician who happens to be in charge decides that the patient is suffering from a disease or a complication not in his field, so he orders his resident to have a physician or some specialist see the patient. The so-called consultant sees him, writes an opinion or accepts him for treatment, and that is that. There is no conference and no consultation. This procedure is expedient and often the only one that is possible, but it is poor training for a resident. It should occasionally be possible to have the consultants, in a conference, discuss what procedures might be best for patients.

The following is a quotation from a paper given by Dr. Barney Brooks before the St. Louis Medical Society in May 1947:

Six years ago, I committed what even some of my most loyal associates considered rank heresy. I brought a psychiatrist and a psychologist into the surgical wards. This was done not only because of an idea I got that the surgical wards were perhaps the place best suited for clinical research on some of the problems of psychiatry, but principally for the purpose of stimulating surgeons-in-training to extend their interests into the psychic as well as the somatic aspects of disease. I have been amazed at the change of viewpoint of even the conscientious objectors who felt quite sure patients would be insulted by even the thought of having to see a psychiatrist to the point of leaving the hospital immediately. There is no doubt in my mind that this venture has influenced greatly my House Staff to think of a patient as a human being rather than a hunk of nonprotein nitrogen and blood sugar without enough hydrogen ion concentration to absorb an autolysing appendix. It has also emphasized the importance of the surgeon's knowing at least a little about a great many things to be able to commune with anyone. A brief mutual understanding may establish a personal relationship between that patient and the surgeon which is of great value for diagnosis and even greater influence for obtaining the most favorable result.

Too great a zeal for technical achievement is often a vice in an otherwise well equipped surgeon. The well trained airplane pilot must be equipped to do all manner of stunts and aerial acrobatics. He must be taught to stall his plane, to go into a spin, recover and level off. All of these are hazardous, but any of the maneuvers may some day save lives. On the other hand, the pilot who drives his plane day in and day out in such a way that these performances are unnecessary is by all odds the best pilot. The zealous exhibitionist who rates his ability by the accomplishment of the spectacular is dangerous. The training of surgeons is analogous. We should teach the young surgeon all the surgical technics that he may some day find necessary to use, but we must also teach him, and by personal example, that too great a zeal for spectacular technical achievement is dangerous and could be interpreted as a means for the acquisition of unwarranted publicity.

Underlying all definitions of education is the concept that it denotes an attempt on the part of adult members of society to shape, in accordance with their own ideals, the development of the coming generation. To this extent we are all educators.

The membership of the Western Surgical Association can be roughly divided into two groups—those who have chosen to follow an academic career and those who in the main are engaged in private practice. The function of the teaching surgeon is to teach. The surgical education of medical students, interns and graduate students specializing in surgery is his first responsibility. He must also be able to contribute to the progress of surgery by his promotion and supervision of intelligent surgical investigation. His judgment must

be critical and unprejudiced in evaluating research. Should he acquire some unusual knowledge or skill in surgery, he should be encouraged to use it for the benefit of the sick and receive compensation from those who can afford to pay him, but he should not use his time, which belongs to his students and co-workers, to perform such surgical procedures as could be done as well or better by other surgeons in the community in which he lives. The criteria of his achievement are competent, honest surgeons whom he has trained and a progressive, productive department of surgery developed under his guidance.

The private practicing physician, especially if he intends to remain in private practice, must also concern himself with his social function. He must do more than give lip service to the Hippocratic Oath and the obligation of the American College of Surgeons. He must realize that in a broader sense he too is an educator in that as an adult member of society he is responsible for the oncoming generation of surgeons and their ideals. Any prestige he may acquire from a grateful following in his community he should use to foster better surgery, better hospital facilities and a better surgical personnel to take over when he must retire.

Right now he is most concerned with what is to become of him and the private practice of surgery. He is fearful to the point of a severe anxiety neurosis. I personally am anxious about, and look with suspicion on, any attempt by society or the government to interfere with the practice of surgery or my way of life, but I must admit that we ourselves are somewhat responsible for the rebellion.

At a meeting of the Rural Health Cooperatives, held in Minnesota, an address was made by an Assistant Secretary of the Interior. He took the position that the recent election was a mandate by the people for medical social reforms, and the sense of the meeting was that the social side of medicine is properly the concern of educators and social philosophers and not of physicians. A prominent Catholic educator, who obviously could not be accused of leaning, even slightly, toward communism, made the categorical statement: "Medical scientists should not invade the social field any more than educators and social philosophers should invade the scientific field."

If his premise is true, that physicians are pure scientists and technicians, completely ignorant of humane social philosophy, his thesis is incontrovertible. But I do not believe that his premise is true. If society has such an opinion, it is our business to change it. I think that this can best be done by interesting ourselves, actively, in the humane and social aspects of our profession and, throughout the entire period of their training, making every effort to instil and develop in the oncoming generation of physicians a recognition of the importance of these attitudes.

REVASCULARIZATION FOLLOWING EXPERIMENTAL MESENTERIC VASCULAR OCCLUSION

RUDOLF J. NOER, M.D.

AND

JOHN WILLIAM DERR, M.D.

DETROIT

THE SMALL intestine has a remarkable ability to withstand interruption of its blood supply. The distribution and anastomoses of its vessels appear to be responsible for its great revascularizing potential, and it has been generally assumed that the peculiar arcuate system of the intestinal tract is the chief factor in overcoming vascular deprivations. Considerable experimental effort has been devoted to determining the degree of vascular interruption which is compatible with life, yet the exact mode by which compensation takes place has not been clearly established. The literature pertinent to these studies may be discussed under two categories—(1) anatomic studies and (2) experimental mesenteric vascular interruption and revascularization of the intestine.

ANATOMIC STUDIES

Morphologic reports on the larger vessels of the small intestine are in accord, but many discrepancies appear in descriptions of the vasa recta and the vessels within the intestinal wall. Much of the confusion doubtless arises from the common failure to recognize the fact that striking species differences exist. Injection studies reported from these laboratories in 1943¹ clearly show that the pattern followed by the intestinal vessels of the dog, for example, differs greatly from that of man. While most species studied fall into one or the other of these two patterns, the variations are striking and sufficiently great to cause confusion if one makes the common error of assuming that a single intestinal vascular pattern is common to all species.

From the departments of surgery and anatomy, Wayne University College of Medicine.

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1. Noer, R. J.: The Blood Vessels of the Jejunum and Ileum: A Comparative Study of Man and Certain Laboratory Animals, *Am. J. Anat.* **73**:293, 1943.

Dwight in 1898 and 1903² presented a brief but clear description of the mesenteric vascular arch system in man and reported that the vasa recta do not intercommunicate until the intestinal wall has been reached. Monks in 1905, 1909 and 1929³ published a series of classic studies of the anatomy of the human small intestine. His papers are chiefly concerned with the mesenteric vessels and their utilization in small intestinal localization; the increasing complexity of the arcuate vessels in the more distal portions of the human small intestine is well portrayed. It is of particular interest that Monks' illustrations have been reproduced from time to time, redrawn in such a way as to show a nonexistent human mesenteric border artery which is neither illustrated nor described in his original papers.

Eisberg in 1924⁴ reported a thorough study of the mesenteric vasculature of both man and dog. Though his illustrations clearly show the differences between these species, he fails to point out that there are communications between the dog's vasa recta but none in man. This paper is particularly noteworthy for its description of the vessels within the intestinal wall and clearly shows the abundant communications which exist between the mural trunks, though it fails to point out the differences between species with respect to these anastomoses.

Mall in 1887⁵ presented a detailed description of the blood and lymphatic vessels of the small intestine of the dog. His account clearly delineates the pattern of the mesenteric arcades, the abundantly intercommunicating vasa recta and the anastomoses between the mural trunks. His descriptions of the finer ramifications of the arteries, veins and lymphatic vessels within the intestinal wall are complete in finest detail, and the paper is a masterpiece unequalled elsewhere in the literature on this subject.

Latarjet and Forgeot in 1910⁶ described the circulation of the jejunum and ileum in man, dog, cat, horse, pig and rabbit. This is the most complete early comparative study, and the observations are

2. Dwight, T.: The Branches of the Superior Mesenteric Artery to the Jejunum and Ileum, *Proc. A. Am. Anat.* **10**:79, 1898; The Branches of the Superior Mesenteric Artery to the Jejunum and Ileum, *Anat. Anz.* **23**:184, 1903.

3. Monks, G. H.: Studies in the Surgical Anatomy of the Small Intestine and Its Mesentery, *Ann. Surg.* **42**:543, 1905; Intestinal Localization, *J. A. M. A.* **52**:1079 (April 3) 1909; Intestinal Localization, *Surg., Gynec. & Obst.* **49**:213, 1929.

4. Eisberg, H. B.: Intestinal Arteries, *Anat. Rec.* **28**:227, 1924.

5. Mall, F. P.: Die Blut-und Lymphwege im Dünndarm des Hundes, *Abhandl. d. math.-phys. Cl. d. k. sächs. Gesellsch. d. Wissensch.*, 1887, vol. 14.

6. Latarjet, A., and Forgeot, E.: Circulation artérielle de l'intestin grêle (duodénum excepté,) chez l'homme et les animaux domestiques, *J. de l'anat. et physiol.* **46**:483, 1910.

carefully presented. These authors stated that they consider the embryologic background an important factor in the adult situation.

Bradley in 1927⁷ gave a brief but accurate account of the mesenteric system in the dog. DeBlasi in 1937⁸ compared the distribution of the superior mesenteric vessels of dog and man. His report included a description of multiple mesenteric occlusion experiments which led him to the conclusion that the human intestine is more efficient in revascularization than that of the dog.

Dieulafé in 1936⁹ reported on injections of the mesenteric vessels of the dog and rabbit with radiopaque mediums. It was his conclusion that the dog possessed a much greater degree of vascularity than the rabbit. Morton in 1929¹⁰ discussed the relative vascularity of the duodenum and ileum of the dog indicating that the more proximal portions of the intestine possess not only larger mural vessels but also more extensive anastomoses between these radicles. (Data reported from this laboratory in 1943¹ confirm this finding.)

Comparative studies of the small intestinal circulation in man and certain laboratory animals were reported from this laboratory in 1943.¹ This report clearly demonstrates the variations among species, with respect to both the larger vessels and the intramural circulation. So far as we know it presents the only complete description of the types of anastomoses within the wall of the intestine in various species. Since this paper was published, additional studies have been made of the rat and the hamster, which indicate that the mesenteric pattern of the rat is similar to that of man, while the hamster, in at least one respect, differs from all the species so far studied.

Special consideration should be given to two frequently quoted papers concerning the blood vessels of the small intestine. The first of these is that by Cokkinis¹¹ published in 1930. This author carried out injection studies on human autopsy specimens, using india ink, and his illustrations clearly show the results obtained. It is of particular interest that he stated: "The collateral circulation stops with the terminal row of arcades. Beyond this there is absolutely no anastomosis, either between the vasa recta in the mesentery or between the

7. Bradley, O. C.: *Topographical Anatomy of the Dog*, London, Oliver & Boyd, 1927, pp. 27-28.

8. DeBlasi, A.: Occlusione dei vasi mesenterici ed infarto intestinale, *Gazz. internaz. med.-chir.* **47**:95-107, 137-151 and 247-255, 1937.

9. Dieulafé, R.: Contribution à l'étude de l'irrigation de l'intestin grêle—Conséquences de la ligature expérimentale des vaisseaux mésentériques, *Arch. d'anat., d'histol. et d'embryol.* **21**:97, 1936.

10. Morton, J. J.: The Differences Between High and Low Intestinal Obstruction in the Dog, *Arch. Surg.* **18**:1119 (April) 1929.

11. Cokkinis, A. J.: Observations on the Mesenteric Circulation, *J. Anat.* **64**:200, 1930.

ramifying vessels on the gut wall. One feels that the last observation contradicts the view of many authors but its accuracy is guaranteed." There can be no doubt, from his illustrations, that his injections failed of complete filling of the finer vessels, but this fact hardly justifies his emphatically stated conclusion that there are no anastomoses at any point distal to the arcuate vessels. Most observers are in complete agreement as to the existence of such anastomoses, and the papers of Dwight,² Mall⁵ and Eisberg⁴ clearly demonstrate them. The report previously referred to¹ contains photographs of injected specimens, including flat mounts of the antemesenteric area which can leave no doubt of the presence of abundant intercommunications between the mural vessels (fig. 3). Proof of this anastomotic mechanism is further adduced in the body of this paper.

A second widely quoted paper is that of Dragstedt, Lang and Millet, published in 1929.¹² These authors expressed the opinion (since then widely accepted as fact) that the vessels of the intestinal wall pierce the muscularis at levels progressively farther from the mesenteric attachment in the more distal portions of the intestine and postulated that this might be an explanation for the greater morbidity and mortality associated with high intestinal obstruction. The paper from this laboratory previously referred to¹ reported on serial sections of injected specimens prepared with special stains in man, dog, chimpanzee and opossum, with a total count of the vessels piercing the muscularis at various levels in both jejunum and ileum. There was no significant variation between the levels of the intestine with respect to the point at which the vessels pierced the muscularis. On the basis of these studies the aforementioned hypothesis appears to be no longer tenable.

EXPERIMENTAL MESENTERIC VASCULAR INTERRUPTION AND REVASCULARIZATION OF THE INTESTINE

The literature contains many references to these subjects, but in only a few are the data sufficiently controlled to justify detailed consideration in this report. One of the earliest and most carefully prepared studies was that of Welch and Mall in 1897, not reported in detail until 1920.¹³ It is of interest that this paper is often misquoted on the basis of incomplete data published in Allbutt's "System of Medicine," 1902 and 1909.¹⁴ From misinterpretation of this work has grown the

12. Dragstedt, C. A.; Lang, V. F., and Millet, R. F.: The Relative Effects of Distention on Different Portions of the Intestine, *Arch. Surg.* **18**:2257 (June) 1929.

13. Welch, W. H., and Mall, F. P.: Experimental Study of Hemorrhagic Infarction of the Small Intestine in the Dog, in Welch, W. H.: *Papers and Addresses*, Baltimore, Johns Hopkins Press, 1920, vol. 1, pp. 77-109.

14. Allbutt, T. C.: *A System of Medicine*, New York, Macmillan & Co., 1909, vol. 6.

erroneous concept that 5 cm. is the maximum length of small intestine in the dog which will withstand mesenteric devascularization. These authors actually showed a high percentage of survival in animals subjected to devascularization of 13 cm. loops. It is of particular significance that they pointed out that some of their data clearly indicate that the reestablishment of circulation in some of these animals could have taken place only through the intramural vessels.

Additional experiments on mesenteric occlusion have been reported by many authors, among them Demel,¹⁵ Eisberg,¹⁶ Murphy and Vincent,¹⁷ Dieulafé,¹⁸ Niederstein¹⁹ and others. These investigators have shown the effects of various types of mesenteric interruption, and although many of their conclusions differ, they are apparently in agreement on the following ideas: first, that in the dog the maximum length of small intestine that will survive mesenteric devascularization is 5 cm.; and, second, that venous occlusion produces a congestive necrosis more hazardous to the animal than arterial deprivation. There is, however, no uniformity of opinion as to the validity of comparing these results with similar situations in man.

The literature on experimental mesenteric occlusion was briefly reviewed and additional data reported from this laboratory in 1948.²⁰ It was shown that interruption of any or all of the mesenteric blood vessels to a 15 cm. segment of the dog's small intestine was followed by death in less than half of the animals so treated. It was further shown that complete vascular deprivation of such a segment could not be uniformly accomplished by interruption of intestinal and arcuate vessels alone. These results supported the belief that revascularization had presumably been accomplished through anastomotic connections within the intestinal wall and/or by way of the marginal plexus peculiar to the dog. Injection studies carried out subsequent to this report have further showed that 15 cm. is likewise the maximum segment

15. Demel, R.: Zur Frage der Ernährung des Darmes bie Gefässunterbindungen im Mesenterium, Arch. f. klin. Chir. **146**:701, 1927.

16. Eisberg, H. B.: Viability of the Intestine, Proc. Soc. Exper. Biol. & Med. **21**:153, 1923; Viability of the Intestine in Obstruction, Ann. Surg. **81**:926, 1925.

17. Murphy, F. T., and Vincent, B.: Experimental Study on the Cause of Death in Acute Intestinal Obstruction, Boston M. & S. J. **165**:684, 1911.

18. Dieulafé, R.: Recherches expérimentales sur certaines lésions segmentaires de l'intestin grêle: infarctus hémorragique, gangrène, iléite, Progrès méd. **67**:449, 1939.

19. Niederstein: Die Zirkulationstörungen im Mesenterialgebiet, Deutsche Ztschr. f. Chir. **85**:710, 1906.

20. Derr, J. W., and Noer, R. J.: Experimental Mesenteric Vascular Occlusion, read before the Forum on Fundamental Surgical Problems, American College of Surgeons, 1948; Surg., Gynec. & Obst., to be published.

of comparably devascularized dog's intestine which can uniformly be filled with injection mediums. Longer segments, which caused death of the animals, similarly failed to fill when injected. In other words, there appears to be a fairly accurate correlation between the length of segments which can be filled by injection and those which are compatible with life after mesenteric vascular interruptions. This method of study may, therefore, be useful with reference to man, in whom experiments are impossible during life.

One clinical report appears most significant with respect to the revascularizing ability of the human intestine. Bost in 1929²¹ presented 3 cases in which patients suffered complete detachment of segments of the small intestinal mesentery varying in length from 4 to 8 inches (10 to 20 cm.). The mesentery was resutured and omentum wrapped about it, after which the patients made a complete recovery. He also reported three experiments of this type in dogs, 2 of which survived after resection of 6 and 8 inches (15 and 20 cm.) of mesentery respectively. In the same year Rothschild²² presented a report on a series of injections in the dog's small intestine which indicated a considerably greater revascularizing power than had formerly been believed. He also expressed the opinion that man possesses a greater factor of safety than does the dog.

EXPERIMENTAL DATA

Repeated arterial injections have been carried out with two technics: (1) liquid latex and (2) india ink. The latter provides a more easy and complete filling of the finer radicles at lower pressures and has accordingly been utilized for most of the studies. Bovine plasma has been utilized to wash the blood from the vessels prior to injection and has routinely been used as the diluent for the ink. Davies and Edwards²³ have called attention to some of the advantages of plasma for injection mediums, and we have found that its use eliminates the edema so often produced by preliminary irrigations with isotonic sodium chloride solutions. Latex specimens were "set" in acetic acid, then fixed in 10 per cent solution of formaldehyde, while the india ink preparations were placed in this fixative immediately after injection.

21. Bost, T. C.: Mesenteric Injuries and Intestinal Viability, *Ann. Surg.* 89:218, 1929.

22. Rothschild, N. S.: Safety Factors in Mesenteric Ligations, *Ann. Surg.* 89:878, 1929.

23. Davies, D. V., and Edwards, D. A.: The Blood Supply of the Synovial Membrane and Intra-Articular Structures, *Ann. Roy. Coll. Surgeons of England*, 1948, pp. 142-156.

The specimens were then cleared for study in the manner described by Noer¹ and by Lathrop and Krupp.²⁴

All the earlier injections were made at pressures between 200 and 250 mm. of mercury. These have since been repeated at pressures of 100 to 150 mm. to approximate more nearly normal arterial pressures. While the vascular filling has been less rapid, the degree and comparative rapidity of filling have shown no significant variations from those obtained at higher pressures.

A total of fifty-one intestinal loops from four different species have been injected after various types of mesenteric vascular interruption, the distribution being as follows:

Man	9 loops
Dog	20 loops
Rabbit	15 loops
Opossum	7 loops

All loops were chosen from the lower part of the jejunum or upper part of the ileum; more proximal or distal areas were not included so as to avoid anastomoses possibly derived from the gastroduodenal or ileocolic arteries.

The human specimens were obtained at autopsy, in most cases several hours after death. Despite the fact that one might expect difficulty from intravascular clotting and from degenerative changes in the vessel walls, good injections were obtained. In no case did extravasation of the injection mediums occur to a degree incompatible with accurate observation, while the fresher material showed no extravasation whatever. The animals studied were anesthetized by the intravenous injection of pentobarbital sodium and the injections carried on during life; death of the animal usually occurred shortly after completion of the injection.

The dog was chosen for study because of its almost universal use in experimental work, despite its differences from man. The opossum and rabbit were selected because of their easy availability as experimental animals with mesenteric vascular patterns morphologically comparable to that of man.¹

Three types of mesenteric vascular interruption have been carried out in each of the species mentioned (fig. 1): (1) ligation and division of the intestinal arteries alone to 15 cm. loops, (2) ligation and division of the intestinal arteries to 15 cm. loops plus the arcuate vessels at the extremities of these loops and (3) ligation and division as in (2) with the added interruption of all the vasa recta to the segment. The last two types of ligation have been carried out in some loops more than 15 cm. long for comparison.

24. Lathrop, G. E., and Krupp, R.: *Microscopy of Latex Rubber-Injected Specimens*, Am. J. Clin. Path. **14**:128, 1944.

In the earlier injection studies some difficulty was experienced in following the sequence of filling of the various vascular elements because of the rapidity with which the vessels filled, even at pressures approximating the normal. This difficulty was finally overcome by "slow motion" cinephotography. Close-up motion pictures of the

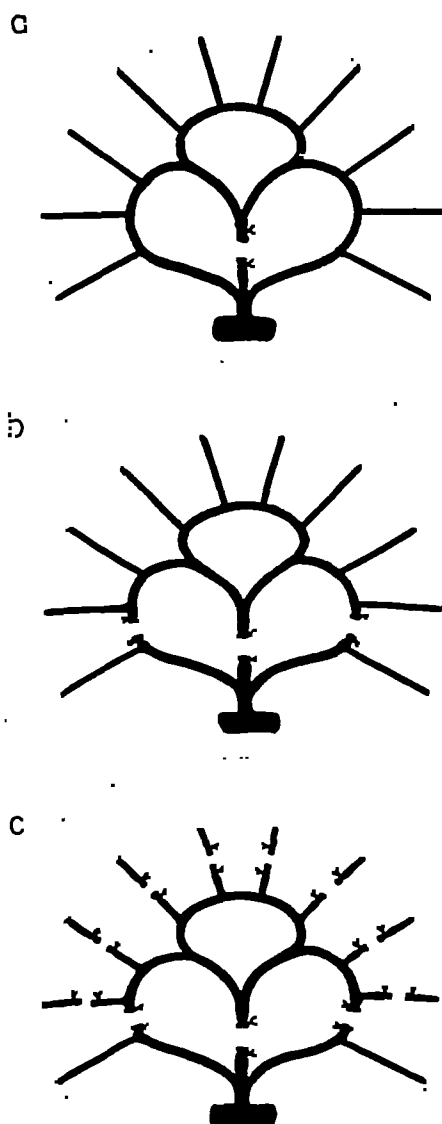


Fig. 1.—Diagrams illustrating types of mesenteric vascular interruption. *a*, division of the intestinal artery alone; *b*, division of the intestinal artery together with the arcuate vessels at each extremity of the loop; *c*, division of the intestinal artery, the arcuate vessels at each extremity of the loop and all the intervening vasa recta.

loops were taken at 64 or 32 frames per second during injection and the developed pictures projected at 16 frames per second to permit detailed study of the course taken by the injection mediums.

RESULTS

1. *Division of the Intestinal Arteries Alone.*—In every case the injection medium filled the loop rapidly and without difficulty, passing from adjacent intestinal arteries by way of the arcuate vessels and vasa recta to the intestinal wall.

2. *Division of the Intestinal Artery Together with the Arcuate Vessels at Each Extremity of the Loop.*—Vascular filling took place by way of the vessels within the intestinal wall at each extremity of the ligated loop, thence to the arcuate system and vasa recta of the interrupted area and into the mural vessels and their areas of anastomosis. Loops longer than 15 cm. failed to fill completely, injection taking place at the ends, while the midportion of the loops remained clear.

3. *Division of the Intestinal Arteries and Arcuate Vessels Plus All the Vasa Recta to the Loop in Question.*—Good filling was obtained in every case by way of the intramural circulation alone. These specimens filled surprisingly well in every instance, and the rate was only slightly slower than that which occurred when the connections between the arcuate vessels and the loop remained intact. It should be pointed out, however, that there is a definite though brief time lag in the filling of the mural vessels as compared with the arcuate system. It is of interest that the rapidity and the degree of filling obtained in the dog was always less than that in the other three species. Only in this animal did we find some specimens failing to fill completely the central portion of the deprived 15 cm. loops.

COMMENT

The results following interruption of the intestinal arteries alone are in accord with the usual ideas on the compensatory mechanisms of the intestinal circulation. The results in the second and third types of occlusion, by contrast, show a surprising and unexpected ability of the intramural anastomoses to reestablish circulation in intestinal loops deprived of part or all of their mesenteric vessels. This finding is at variance with most published ideas on the subject, though the possibility was suggested by Welch and Mall in 1897.¹³ Since the findings have been repeatedly confirmed in all the species studied, it is apparent that the intramural circulation is of far greater importance in revascularization than has hitherto been supposed.

Several questions are raised by the slower and less complete filling of the dog loops. One of these is the part played by the circular muscular contraction commonly seen in the intestine of this animal in response to vascular deprivation (an effect seldom seen in other species). Many authors have reported this rather striking phenomenon and believe that revascularization is but poorly accomplished in

its presence. We found this contraction the rule in dog intestine, and we know from quartz rod transillumination studies that there is considerable interference with blood flow in the intestinal wall during peristaltic contraction. To eliminate this as a possible factor, 1 dog was killed the day before injection of its intestine. There was no demonstrable difference in the filling of this dead animal's vessels despite complete absence of intestinal contraction.

Another possible explanation for the poorer filling of the dog loops appears to be the type of anastomosis between the vessels within the intestinal wall. Though descriptions of these vessels were included in the 1943 report previously mentioned,¹ it seemed advisable to reevaluate this situation with the present problem in mind. Accordingly the mural circulation was restudied in injected specimens of intestines of man, dog, rabbit and opossum, with the aid of gross inspection and



Fig. 2.—Diagram of the type of intramural and antemesenteric anastomoses within the intestinal wall. *a*, direct intercommunications between the mural trunks typically seen in man and the opossum and to a lesser extent in the rabbit; *b*, the "plexiform" anastomotic pattern commonly seen in the dog. Note that the anastomoses are only by fine communicating vessels; *c*, intramural anastomoses formed by arcuate vessels lying near the antemesenteric border. This type is characteristic of the rabbit.

examination with the wide field binocular microscope. These studies confirmed the 1943 report in every respect (figs. 2 and 3). Briefly, the vessels of the intestinal wall may be said to communicate with each other through three general types of anastomoses: (1) direct cross communications between the mural trunks, (2) "plexiform" anastomoses in which the adjacent vessels break up into fine radicles which then anastomose with each other and (3) arcuate communicating vessels which run parallel to the long axis of the intestine to connect adjacent mural vessels along the side of the intestine, usually near the antemesenteric border. The first type is best seen in the human intestine and also in the opossum. The third type is characteristic of the rabbit

and is occasionally seen in the opossum and more rarely in other species. The dog shows chiefly the plexiform type of mural intercommunications and has few direct anastomoses between the mural ves-

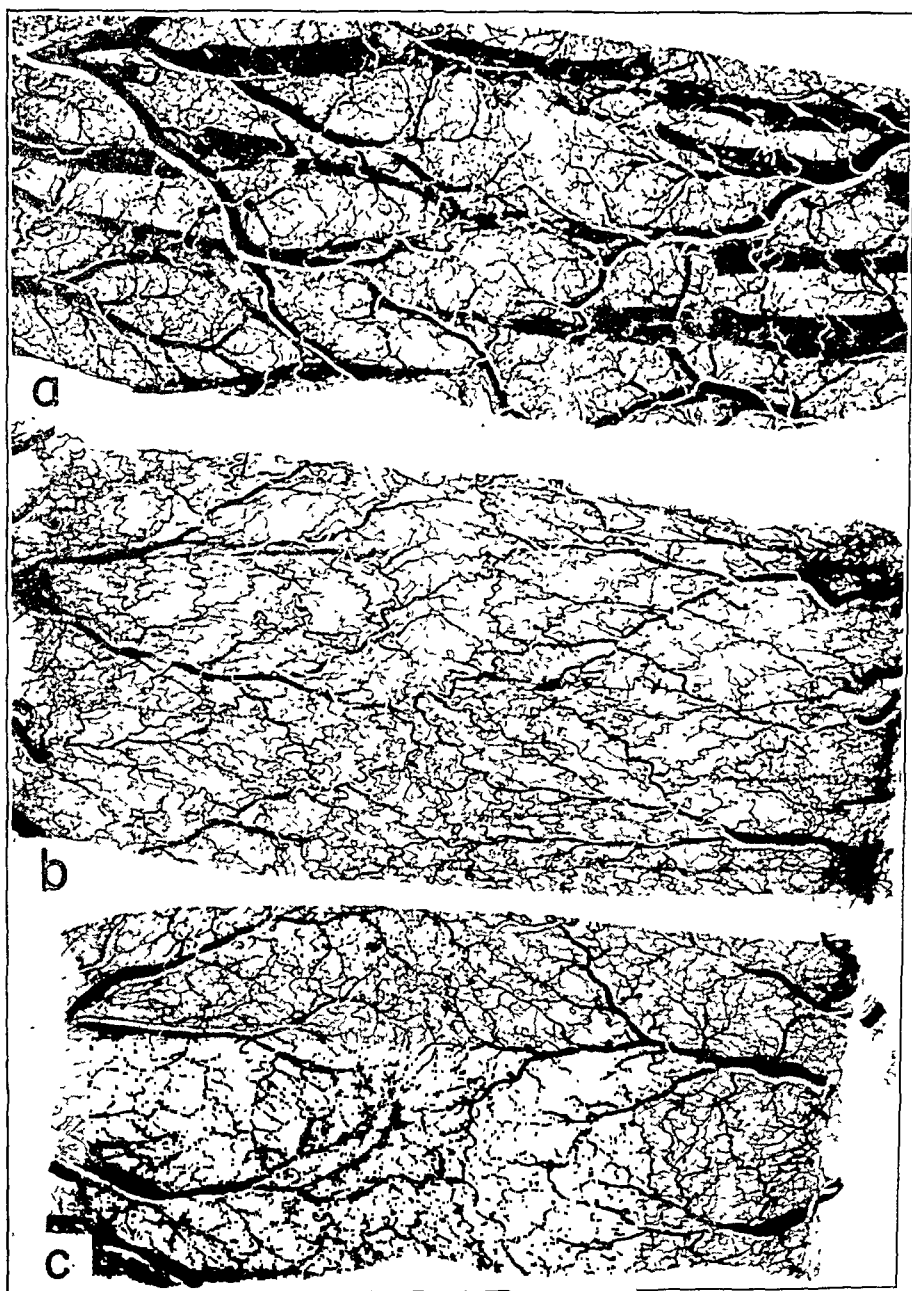


Fig. 3.—Photograph of the anastomoses within the wall and in the antemesenteric border of human specimens (compare with fig. 2). *a*, jejunum; *b*, upper ileum; *c*, lower ileum.

sels. It is our impression that this situation best explains the poorer filling seen in dog loops injected after mesenteric vascular deprivation.

Since the intramural circulation appears to be such an important factor in revascularization, one cannot but speculate on the effect which distention might exert on the efficiency of these anastomoses. Preliminary experiments indicate that even moderate degrees of dis-

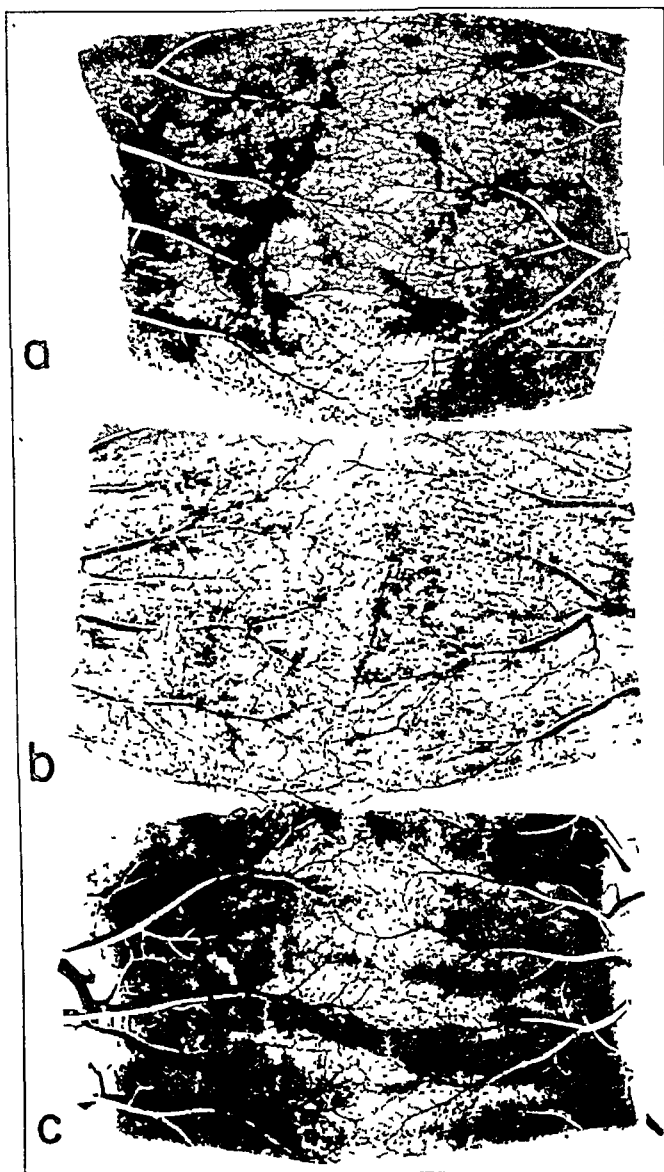


Fig. 4.—Photograph of the mural anastomoses and antemesenteric areas of dog intestine (compare with fig. 2). *a*, jejunum; *b*, upper part of ileum; *c*, lower part of ileum.

tention may greatly vary the ability of the mural circulation to establish blood supply in partially devascularized intestine. If such actually is the case, the need for decompression in the treatment of all types of intestinal distention assumes added importance. Further studies on this point are in progress.

CONCLUSIONS

1. Injection of partially devascularized intestinal loops provides a convenient method for studying routes available for revascularization. There is sufficient correlation between survival in animals and the ability to inject such loops to justify guarded inferences based on results of injection studies.

2. After ligation of intestinal arteries alone, the deprived loops fill rapidly from adjacent intestinal arteries by way of the arcuate vessels and their vasa recta into the intestinal wall.

3. After ligation of the intestinal arteries together with the arcuate vessels at each extremity of 15 cm. loops of intestine, good filling takes place through the vessels of the intestinal wall, thence to the arcuate system and its vasa recta and into the mural vessels.

4. A 15 cm. loop can be well injected after ligation of its intestinal arteries, the arcuate vessels at each extremity and all its vasa recta. In this case filling is accomplished solely by anastomoses between the vessels of the intestinal wall.

5. The revascularizing potential of the dog in these circumstances appears to be somewhat less than that of man, opossum and rabbit.

6. While its efficiency in a given species appears to be dependent on the type of intramural anastomoses, it is clear that the circulatory system within the intestinal wall provides an added and important compensatory mechanism over and above that found in the arcuate system.

Dr. Charles G. Johnston, Professor of Surgery, and Dr. Gordon H. Scott, Professor of Anatomy, Wayne University College of Medicine, gave their continued interest and helpful suggestions during the course of this investigation.

DISCUSSION

DR. CHARLES G. JOHNSTON, Detroit: I have little to say except that I hate to miss this opportunity to say a word about this rather painstaking work which Dr. Noer and Dr. Derr have been carrying on for several years. I am sure those of you who do any amount of intestinal surgery will get a great deal of comfort from the pictures illustrating the amount of revascularization that is possible through the intestinal wall. I have long feared the use of a loop which has been fairly well devascularized, especially in the use of small intestine for the Roux Y procedure, always fearing that perhaps I was taking off too much mesentery. It is pretty obvious from these experiments that so long as one maintains the arcuate system there is a good anastomotic blood flow through the entire area of the gut, so one can take a fairly long loop. The great trouble usually is that the mesentery holds the small bowel down, and it becomes necessary to free it. These studies give me a great deal of comfort.

Dr. Noer and Dr. Derr have been carrying on these studies in a large series of species, and the great amount of detail which they have been able to bring out in the vessels in the wall itself is amazing. I must say that I was critical of

their work when I first saw them, because I had no idea that so fine an anastomosis could be obtained through the intestinal wall itself, with all the arcuate vessels completely tied. This is a long loop to devascularize completely and still maintain a blood supply. Dr. Derr and Dr. Noer have not only done this so far as the injected specimens are concerned but likewise have done it in several species of animals, and the results are the same. I am sure that from their comparable results on autopsy material from human beings we can expect a much better vascularity in the intestinal tract than we had previously supposed existed; so we have a great deal of leeway in the use of intestine that is partially devitalized.

DR. JOHN H. OLWIN, Chicago: Is there any information as to the ease of the return circulation compared to the arterial flow in the animals that survived? Was there any noticeable engorgement of the loops in the animals that survived?

DR. RUDOLF J. NOER, Detroit: There was no engorgement of the loops in the animals that survived, with the exception of those in which only the veins were ligated. There was some engorgement when the veins were ligated without the arteries.

As far as the ease of return of the circulation is concerned, those animals which had an arterial deprivation alone appeared somewhat pale immediately after the ligation. The loops were not kept out of the abdomen very long, and on examination at autopsy after ten day survivals the loops appeared somewhat anemic but otherwise were relatively normal. They were rather pale in appearance and somewhat smaller in caliber than the other loops.

USE OF PORTACAVAL ANASTOMOSIS IN PORTAL CIRRHOSIS

A. C. PATTISON, M.D.
PASADENA, CALIF.

PORTAL cirrhosis is progressively increasing in importance as a medical and economic problem. The rising incidence of this disease at autopsy at the Los Angeles County Hospital is indicated in table 1. The reports of Whipple,¹ Blakemore² and Blalock³ on portacaval anastomosis have established the feasibility of surgical alleviation of certain of the distressing features exhibited by patients with advanced portal cirrhosis. The experience of my colleagues and me with the problem is presented in the following report of 14 cases, in 10 of which this operative procedure has been carried out. In all 10 cases the portal vein has been anastomosed to the inferior vena cava.

The portal system of veins is interposed between two capillary beds, that of the gastrointestinal tract, pancreas, spleen and gallbladder and that of the liver. Obstruction involving the capillaries of the bed of the liver or of the major vessels of the portal system may produce portal hypertension. Therefore, cases of portal hypertension can be divided into two main groups, those with intrahepatic portal block and those with extrahepatic portal block.

Cirrhosis of the liver, particularly the portal type, is by far the most common cause of intrahepatic portal block. Early in portal cirrhosis there are few if any clinical symptoms or signs, and often it is not until the resulting portal hypertension becomes excessive that there is awareness of the disease. Also, in patients with portal cirrhosis of pathologically similar degree the clinical manifestations vary. Thus, 1 patient

From the Department of Surgery, University of Southern California, Los Angeles.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 2, 1948.

1. Whipple, A. O.: The Problem of Portal Hypertension in Relation to the Hepatosplenopathies, *Ann. Surg.* **122**:449 (Oct.) 1945; The Rationale of Portacaval Anastomosis, *Bull. New York Acad. Med.* **22**:251 (May) 1946.

2. Blakemore, A. H.: Portacaval Anastomosis: A Report of Fourteen Cases, *Bull. New York Acad. Med.* **22**:254 (May) 1946; Indications for Portacaval Anastomosis—Analysis of Cases, *Surg., Gynec. & Obst.* **84**:645 (April) 1947.

3. Blalock, A.: The Use of Shunt or By-Pass Operations in the Treatment of Certain Circulatory Disorders, Including Portal Hypertension and Pulmonary Stenosis, *Ann. Surg.* **125**:129 (Feb.) 1947.

may have no signs of excessive portal pressure, another may have splenomegaly, another splenomegaly with hematemesis, another ascites only and others ascites with splenomegaly alone or associated with hemorrhages. To date our surgical experience has been confined entirely to the group presenting either ascites and/or hemorrhages from esophageal varices.

The surgical approaches of the past, for the most part, have proved disappointing in alleviation of both morbidity and mortality in this dis-

TABLE 1.—*Incidence of Portal Cirrhosis at Autopsy at Los Angeles County Hospital*

Year	Number of Cases	Cases of Portal Cirrhosis	Percentage
1918 to 1932.....	9,527	62	0.65
1933 to 1937.....	8,347	155	1.84
1938.....	.....	..	....
1939.....	2,097	73	3.48
1940.....	2,308	91	3.94
1941.....	2,185	130	5.95
1942.....	2,109	122	5.78
1943.....	1,801	90	4.99
1944.....	1,638	71	4.34
1945.....	1,527	87	5.69
1946.....	1,785	116	6.49
Total.....	33,324	997	

TABLE 2.*—*Prognosis in Portal Cirrhosis with Ascites*

	Mortality	
	Treated Patients (115), Percentage	Untreated Patients (230), Percentage
1 yr.....	35	61
2 yr.....	50	79
5 yr.....	70	93

* From the article by Patek and others.⁵

ease. Therefore, before considering any operative procedure, it would be well first to analyze the prognosis in portal cirrhosis. Ratnoff and Patek⁴ and Patek and his associates⁵ have made such a study. Table 2 is adapted from the latter and illustrates the outlook in cases with ascites. At the present time there are no adequate figures for the group of patients presenting hemorrhage from esophageal varices who have

4. Ratnoff, O. D., and Patek, A. J.: The Natural History of Laennec's Cirrhosis of the Liver, *Medicine* **21**:207 (Sept.) 1942.

5. Patek, A. J.; Post, J.; Ratnoff, O. D.; Mankin, H., and Hillman, R. W.: Hepatic Cirrhosis, *J. A. M. A.* **138**:543 (Oct. 23) 1948.

had the obvious benefit of a present day medical regimen. However, previous figures ⁴ on untreated series show the group with hematemesis to have a mortality curve similar to the group with ascites. Also, it is most interesting, and certainly significant therapeutically, that 40 per cent of patients who have hemorrhage from esophageal varices die within one month of the first hemorrhage.

All this crystallizes into an ominous prognosis for the person with advanced portal cirrhosis, and it would seem that any operative procedure, provided it will give a significant measure of relief to the patient, is worthy of serious consideration. Decreasing the portal hypertension by portacaval anastomosis should, on a purely mechanical basis, greatly lower the incidence of hemorrhage. With the ascites of portal cirrhosis resulting from an increase in portal hydrostatic pressure in conjunction with a reduced osmotic pressure of the blood and probably an increase in capillary permeability, measures aimed at decreasing the portal pressure also should aid in the control of the ascites. What the decrease in portal pressure and blood flow does to the functional status of the liver is still conjectural, although, as will be shown subsequently, there is no evidence that shunting the portal blood away from the cirrhotic liver decreases its function.

Table 3 is a fairly comprehensive list of the surgical procedures that have been employed in portal cirrhosis. Until recently none of these procedures has carried any significant degree of promise, and in large series reported ⁶ 40 to 55 per cent of the patients operated on were dead within one month. The surgical procedures most frequently utilized in the past were (1) splenectomy, (2) ligation of the tributaries to the esophageal varices, (3) omentopexy and (4) peritoneosubcutaneous drainage. None of these procedures has produced sufficiently satisfactory results. On the basis of the vascular physiology in portal cirrhosis as it is now known and with the development of satisfactory methods of vascular anastomosis, the shunting of the portal blood stream into the inferior vena cava appears to be a logical procedure, not with the thought of altering the already developed hepatic changes, but with the hope of controlling ascites and/or esophageal hemorrhages. Of the two basic operative procedures, anastomosis of the splenic vein to the left renal vein or anastomosis of the proximal end of the severed portal vein to the inferior vena cava, we feel that the latter is the preferable operation in portal cirrhosis for two reasons: (1) the larger stoma will conduct more blood and consequently lower the portal pressure to a greater degree, and (2) the animal experiments of Blalock ³ indicate a higher incidence of postoperative thrombosis at the site of splenorenal anastomoses.

6. Henrikson, E. C.: Cirrhosis of the Liver, *Arch. Surg.* **32**:413 (March) 1936.

Fourteen patients with portal cirrhosis, presenting either ascites or hemorrhage from esophageal varices, have been operated on, and an end to side portal vein—inferior vena cava anastomosis has been accomplished in 10 cases. In 1 of the 4 cases in which the anastomosis was not done a dense plastic peritonitis, following over seventy paracenteses, made identification of any intra-abdominal structure almost impossible. In another case, with hemorrhage from esophageal varices, in which the spleen had been removed four years previously, there was completely organized thrombotic obliteration of the portal vein. Another patient with severe ascites also had completely organized thrombotic obliteration

TABLE 3.—*Operations for Portal Cirrhosis (Portal Hypertension)*

-
- | | |
|--|---|
| A. Establishing Collateral Circulation | |
| 1. Omentopexy | Morison-Talma—G. O. to anterior abdominal wall plus glass tube
Turner—G. O. between liver and diaphragm
Schiassi-Barker—G. O. between peritoneum and posterior rectus
Narath—G. O. between skin and superficial fascia |
| 2. Visceropexy | |
| Hepatopexy | |
| Splenoepexy | To peritoneum (Bunge)
To pockets in abdominal wall
Testicle and venous plexus intra-abdominally to G. O. (Lanz)
Excision of patches of peritoneum |
| B. Ligation of Vessels | |
| 1. All tributaries of portal vein have been ligated, except splenic | |
| Coronary | |
| Inferior mesenteric (Moynihan) | |
| Superior mesenteric | |
| 2. Ligation of splenic artery | |
| 3. Injection of esophageal varices (Moersch) | |
| 4. Gastric resection (Wangensteen) | |
| 5. Esophagogastrectomy (Phemister—for extrahepatic obstruction) | |
| C. Short Circuiting Operations | |
| 1. Eck Fistula (Vidal—1903) | |
| 2. Superior mesenteric to spermatic or ovarian veins | |
| 3. Superior mesenteric to inferior vena cava (Bogoraz and Krestovsky) | |
| D. Methods for Draining Ascitic Fluid | |
| 1. Saphenoperitoneal anastomosis (Ruotte) | |
| 2. Subcutaneous drainage through femoral canal (Handley) | |
| 3. Peritoneosubcutaneous drainage with glass tubes (Bocarro-Tannahill) | |
| 4. Bladder fistula | |
| 5. Pyeloperitoneal anastomosis | |
| E. Splenectomy | |
-

of the portal vein. This man died two months after the exploration, just prior to operation for splenorenal shunt, death being the result of an initial massive hemorrhage from esophageal varices. Operation on the fourth patient, a man with severe ascites, had to be terminated because of excessive hemorrhage from the veins of Retzius, encountered while the duodenum and head of pancreas were being elevated from the inferior vena cava. This man received 4,500 cc. of blood but succumbed to hemorrhagic shock postoperatively.

In 10 cases an end to side portal vein—inferior vena cava anastomosis was completed. Death occurred postoperatively in 1 case (8) and was the result of hemorrhage from the inadvertent tearing of the

pyloric vein at its junction with the portal vein, the hemorrhage occurring postoperatively. All the other patients survived the operation and were discharged ambulatory from the hospital. Table 4 lists the operative findings, other than the cirrhosis, that are considered important from a prognostic standpoint. In 4 cases, 1, 5, 8 and 9, the essential disability was massive hemorrhage from esophageal varices, and in the remainder the problem was medically uncontrollable ascites. All patients had been on medical management for prolonged periods. The relative size of the spleen is indicated in the table, as are the pressures in the portal vein and inferior vena cava in centimeters of water. On the basis of this small series there are three operative findings that seem to be significant in the prognostication of the ultimate result. These are the size of the spleen, the height of the pressure in the portal vein

TABLE 4.—*Venous Pressure at Operation (Normal Pressure in Portal Vein, 6 to 12 Cm. of Water)*

Case	Preshunt		Postshunt Portal Vein	Size of Spleen
	Portal Vein	Vena Cava		
1 *.....	35	15	..	5 times normal
2 †.....	32	20	..	3 times normal
3 †.....	12	5	9	Normal
4 †.....	28	18	22	4 times normal
5 *.....	60	12	26	8 times normal
6 †.....	35	9	28	8 times normal
7 †.....	35	15	23	3 times normal
8 *.....	33	14	17	Absent
9 *.....	40	14	17	8 times normal
10 †.....	25	..	20	1.5 times normal

* Hemorrhage from esophageal varices occurred in these cases.

† Ascites was present in these cases.

and the difference in the degree of pressure between the portal vein and the inferior vena cava. In case 6 the expressed criteria would prognosticate a good end result. Unfortunately an organized portal vein thrombosis which had recanalized was found at operation as an additional finding, the lumen of the vein being approximately one-third the normal size. In spite of this an anastomosis was done, with a resulting drop of 7 cm. of water in the pressure of the portal vein. This was enough to lengthen the period between abdominal paracenteses from less than one week to a ten to fourteen day interval. Possibly a splenorenal anastomosis would have been preferable in this case, and it was being considered as a future procedure until the sudden death of the patient at home six weeks postoperatively from massive hemorrhage of the upper intestinal tract.

Several years must elapse before one can assess the true value of this operative procedure. Table 5 summarizes the results obtained

in this series to date. The results in the group with massive hemorrhage from esophageal varices have been particularly gratifying, for no subsequent massive hemorrhages have occurred. The regression in the size of the varicose veins from the decrease in pressure in the portal vein might be compared to the decrease in the size of varicosities in the lower extremities following reduction in pressure from ligation of the saphenous vein.

The group with ascites is more complex, mainly because of the multiple factors involved in the production of ascites. In only 1 case, 4, was the ascites immediately controlled after operation. In case 3, in which no postoperative improvement was shown, the anastomosis should not have been done because studies of venous pressure failed to show portal hypertension. One fact seems to be developing, that assessment of the end result cannot be made immediately. In case 2

TABLE 5.—*End Results of Portacaval Anastomoses*

Group with Hemorrhage	
1	No further hemorrhages
5	No further hemorrhages
9	No further hemorrhages
8	Postoperative death—hemorrhage
Group with Ascites	
2	No ascites
4	No ascites
3	No improvement
10	No improvement
7	Moderate improvement
6	Slight improvement; sudden death six weeks after leaving hospital from massive hemorrhage of upper part of intestinal tract

there was no improvement whatsoever for five months, then a gradual lessening of the ascites over a two month period, and in the past six months there has been no evidence of intra-abdominal fluid. This same mechanism seems to be working in cases 7 and 10.

The most grave objection to this operation has been the conjecture relative to the functional status of the already damaged liver when the portal blood flow is completely shunted from its parenchyma. In reality this objection was answered by McIndoe⁷ in 1928, when he demonstrated by infusion studies how really little of the portal blood flow passes directly through the cirrhotic liver. In essence, the patient with portal cirrhosis attempts to establish his own Eck fistula through the medium of the extensive collateral circulation that develops.

Many preoperative and postoperative liver function tests have been done in all these cases. Table 6 lists the highest serum albumin and

7. McIndoe, A. H.: Vascular Lesions of Portal Cirrhosis, *Arch. Path.* 5:23 (Jan.) 1928.

globulin measurements before and after shunt. In no instance was there a significant drop in the serum albumin postoperatively, and in the first 2 patients operated on there is now an appreciable rise. The cephalin flocculation, thymol turbidity and sulfobromophthalein tests uniformly have shown no decrease in function and often a significant improvement. In this series the prothrombin time has been neither normal nor down to a critical level preoperatively or postoperatively, with one exception. In case 1, between the second and third postoperative weeks, a considerable amount of blood oozed from the gastrointestinal tract. At this time all reactions to liver function tests were normal except for the prothrombin time, which was in the bleeding range. Sixty milligrams of vitamin K daily was required to keep the prothrombin time above the bleeding range. This dosage was slowly

TABLE 6.—*Serum Albumin and Globulin Levels in Portal Cirrhosis*

Case	Preshunt		Postshunt		Interval, Mo.
	Albumin	Globulin	Albumin	Globulin	
1.....	4.4	3.9	4.8	2.2	15
2.....	3.4	3.6	5.1	2.7	13
3.....	4.0	2.8	3.8	2.7	10
4.....	4.0	4.7	3.8	4.2	11
5.....	3.8	1.4	4.0	1.2	10
6.....	2.6	1.0	2.6	2.6	1
7.....	3.7	3.0	3.5	2.2	6
8.....	3.5	2.9	...	...	..
9.....	3.2	2.7	3.2	2.8	2
10.....	3.6	2.9	2.8	2.9	2

decreased until the end of the second postoperative month, when 12 mg. daily was adequate. This dosage had to be maintained until the fifteenth postoperative month, the prothrombin time from then on remaining at a normal level without the use of vitamin K.

SUMMARY OF CASES

CASE 1.—A white woman, aged 46, with chronic alcoholism, had repeated severe hemorrhages of the upper part of the gastrointestinal tract for fourteen months, being hospitalized for a total of twelve months during this period. On physical examination the edge of the liver was 5 cm. below the costal margin, there was no ascites and the spleen was not palpable. Liver function tests revealed depression following hemorrhages, but all tests gave results which were within normal limits preoperatively. The serum albumin and globulin levels were 4.4 and 3.9 Gm. per hundred cubic centimeters respectively. At operation on March 7, 1947, the liver was moderately enlarged, firm and nodular, and the biopsy revealed moderate portal cirrhosis. There was no ascites, and the spleen was estimated at five times the normal size. The pressure in

the portal vein was 35 cm. of water, and that in the inferior vena cava was 15 cm. of water. Postoperatively, during the second week, oozing developed in the gastrointestinal tract, the prothrombin time was 5 per cent of normal and the patient had to be given 60 mg. of vitamin K daily to keep the prothrombin time above the bleeding range. The necessary dosage slowly decreased, although vitamin K had to be given daily for fifteen months. During this period all other liver function tests gave normal results. The present serum albumin and globulin levels are 4.8 and 2.2 Gm. respectively. The patient has been working since the fourth postoperative month and has had no subsequent hemorrhages.

CASE 2.—A Mexican woman, aged 40, with chronic alcoholism, had pronounced ascites continuously for six months which necessitated weekly paracentesis. On physical examination the liver was not palpable, there was marked ascites and the spleen was not palpable. Liver function tests showed moderate depression, the initial serum albumin and globulin levels being 2.9 and 3.9 Gm. per hundred cubic centimeters and ultimately stabilizing at 3.4 and 3.6 Gm. respectively. At operation on Sept. 5, 1947, the liver was slightly contracted, firm and nodular, and biopsy revealed moderate portal cirrhosis. There was considerable ascites, and the spleen was estimated at three times normal size. The pressure in the portal vein was 32 cm. of water and that in the inferior vena cava 20 cm. of water. Immediately after operation there was no change in the degree of ascites. However, seven months later the ascites had completely regressed, and there has been no subsequent intra-abdominal fluid. The present serum albumin and globulin levels are 5.1 and 2.7 Gm. per hundred cubic centimeters respectively.

CASE 3.—A white woman aged 46 had portal cirrhosis of unknown cause. There had been abdominal distention for one and one-half years, which necessitated paracentesis at bimonthly intervals. Physical examination revealed decided ascites, and the liver and spleen were not palpable. After medical treatment the serum albumin and globulin levels were 4.0 and 2.8 Gm. per hundred cubic centimeters respectively. At operation on Sept. 26, 1947, the liver was normal in size, firm and finely nodular. Biopsy revealed portal cirrhosis with regeneration. The spleen was normal in size, and the pressure in the portal vein was 12 cm. of water while that of the inferior vena cava was 5 cm. of water. After anastomosis the pressure in the portal vein was 9 cm. It has been necessary to continue paracentesis at monthly intervals. The serum albumin and globulin levels are now 3.8 and 2.7 Gm. respectively.

CASE 4.—A Mexican man, aged 43, with chronic alcoholism, was known to have cirrhosis of five years' duration and had had ascites for one year which necessitated ten paracenteses. On physical examination the liver was 4 cm. below the costal margin, there was notable ascites and the spleen was not palpable. After medical treatment the serum albumin and globulin levels were 4.0 and 4.7 Gm. per hundred cubic centimeters respectively. At operation on Oct. 12, 1947, the liver was moderately decreased in size, firm and hobnailed, and biopsy revealed advanced portal cirrhosis. The spleen was four times normal size, the pressure in the portal vein was 28 cm. of water and that in the inferior vena cava was 18 cm. of water. After anastomosis the pressure in the portal vein was 22 cm. At no time has this patient shown evidence of abdominal fluid since operation. The serum albumin and globulin levels are now 3.8 and 4.2 Gm. respectively.

CASE 5.—A white man, aged 47, had four severe hemorrhages in the ten months preceding operation. The liver was not palpable, there was no ascites and the spleen was palpable 6 cm. below the costal margin. All liver function tests gave essentially normal results immediately after operation. The serum albumin and globulin levels were 3.8 and 1.4 Gm. per hundred cubic centimeters respectively. Roentgen study revealed extensive varicosities extending up into the cervical esophagus. At operation on Oct. 23, 1947, the liver was of normal size and finely nodular, and biopsy revealed portal cirrhosis. There was no ascites, and the spleen was at least eight times the normal size. The pressure in the portal vein was 60 cm. of water, and the pressure in the inferior vena cava was 12 cm. of water. After anastomosis the pressure in the portal vein was 26 cm. On the patient's discharge, seven days postoperatively, the spleen was no longer palpable. The subsequent serum albumin and globulin levels measured 4.0 and 1.2 Gm. per hundred cubic centimeters respectively. There have been no further hemorrhages, and the patient's general health is excellent.

CASE 6.—A white woman, aged 40, became ill seven years previous to her admission to the hospital with hematemesis, tarry stools and ascites. She was operated on four years previously, when the splenic vessels were ligated. Subsequently there had been mild hemorrhages on three occasions and a progressively severe ascites, which in the past two months had necessitated paracentesis at seven day intervals. On physical examination the liver was not palpable, there was considerable ascites and the spleen was 6 cm. below the costal margin. Roentgen study revealed the presence of moderate esophageal varices. All liver function tests showed considerable depression, and after medical treatment the serum albumin and globulin levels were 2.6 and 1.0 Gm. per hundred cubic centimeters respectively. At operation on Jan. 10, 1948, the liver was markedly contracted, firm and hobnailed, being less than one third the normal size. There was pronounced ascites, and the spleen was eight times the normal size. The portal vein was two thirds occluded by an old thrombus which was completely organized. The pressure in the portal vein was 35 cm. of water, and that in the inferior vena cava was 9 cm. of water. After anastomosis the pressure in the portal vein was 28 cm. Postoperatively the interval between paracenteses lengthened to ten to twelve days. The serum albumin and globulin were 2.6 and 2.6 Gm. per hundred cubic centimeters respectively. The patient died at home forty-three days postoperatively from a massive hemorrhage in the upper gastrointestinal tract. At autopsy the site of anastomosis was completely occluded by a recent thrombus.

CASE 7.—A white man, aged 50, with chronic alcoholism, had intermittent ascites for three years and continuous ascites for one year. An unsuccessful peritoneosubcutaneous drainage had been done seven months previously. In the past year paracentesis had been performed twenty-six times, with a total of 668 pounds (303 Kg.) of fluid removed, the protein content of which was estimated at forty times the amount of the normal circulating albumin. Physical examination revealed ascites and an umbilical hernia; the edge of the liver was 5 cm. below the costal margin, and the spleen was 2 cm. below the costal margin. After medical treatment the serum albumin and globulin levels were 3.7 and 3.0 Gm. per hundred cubic centimeters respectively. At operation on Jan. 19, 1948, the liver was contracted, firm and nodular, and biopsy revealed portal cirrhosis. The spleen was estimated at three times the normal size, the pressure

in the portal vein was 35 cm. of water and that in the inferior vena cava was 15 cm. of water. After anastomosis the pressure in the portal vein was 23 cm. At the present time paracentesis is necessary at monthly intervals. His average gain in weight is now 0.7 pounds (0.35 Kg.) per day whereas before operation it was 3.0 pounds (1.3 Kg.) per day. The present serum albumin and globulin levels are 3.5 and 2.2 Gm. respectively.

CASE 8.—A white male aged 25 had his first massive hemorrhage in the upper gastrointestinal tract in 1943. In 1944 a splenectomy was done, the pathologic report being "fibrosis of the spleen—Banti's syndrome." In 1946 there was a short interval of jaundice. In the first six months of 1948 he had two severe hemorrhages of the upper intestinal tract. On physical examination there was a scar in the upper midline area, the edge of the liver was just palpable and there was no ascites. Roentgen study revealed the presence of moderate esophageal varices. After medical treatment the serum albumin and globulin levels were 3.5 and 2.9 Gm. per hundred cubic centimeters respectively. At operation on July 10, 1948, the liver was not enlarged and was firm and finely nodular; biopsy revealed portal cirrhosis. The spleen was absent, and no accessory spleens were found. The pressure in the portal vein was 33 cm. of water and that in the inferior vena cava 14 cm. of water. An old organized thrombus was present in the portal vein, which only slightly occluded the lumen. After anastomosis the pressure in the portal vein was 17 cm. of water. The patient died nine hours postoperatively from shock secondary to massive intra-abdominal hemorrhage. At autopsy the source of the hemorrhage was the portal vein at the site where the pyloric vein had been torn across. The anastomosis was patent.

CASE 9.—A white woman aged 54 had been ill for twenty-four months, during which time she had six massive gastrointestinal hemorrhages. On physical examination the edge of the liver was down 3 cm. below the costal margin, there was no ascites and the spleen was down 6 cm. below the costal margin. Roentgenologic study revealed the presence of moderate esophageal varices. After medical treatment the serum albumin and globulin levels were 3.2 and 2.7 Gm. per hundred cubic centimeters respectively. At operation on Aug. 10, 1948, the liver was of normal size, firm and finely nodular; biopsy revealed portal cirrhosis. There was no fluid, and the spleen was eight to ten times the normal size. The pressure in the portal vein was 40 cm. of water, and that in the inferior vena cava was 14 cm. of water. After anastomosis the pressure in the portal vein was 17 cm. On the fourth postoperative day the spleen was no longer palpable. There have been no subsequent hemorrhages. The serum albumin and globulin levels are now 3.2 and 2.8 Gm. respectively.

CASE 10.—A white man aged 26, whose cirrhosis was of undertermined origin, although possibly he had had infectious hepatitis three years previously, had ascites for twenty-eight months, necessitating aspiration at four week intervals. On physical examination there was ascites, the edge of the liver was 4 cm. below the costal margin and the spleen was not palpable. After medical treatment the serum albumin and globulin levels were 3.5 and 2.9 Gm. per hundred cubic centimeters respectively. At operation on Aug. 27, 1948, the liver was moderately enlarged, firm and hobnailed, and biopsy revealed portal cirrhosis. The spleen was estimated at one and one-half times normal size, and the pressure in the portal vein was 25 cm. of water. After anastomosis this pressure

was 20 cm. of water. Postoperative paracentesis was done at two week intervals. Subsequently this interval has slowly increased, until at the present paracentesis is done at four week intervals. The present serum albumin and globulin levels are 2.8 and 2.9 Gm. respectively.

CONCLUSIONS

1. The incidence of portal cirrhosis at autopsy is increasing.
2. The poor prognosis in portal cirrhosis warrants the use of any operative procedure that offers a significant measure of relief to the patient.
3. Anastomosing the portal vein to the inferior vena cava shows definite promise in the alleviation of ascites and hemorrhage from esophageal varices in portal cirrhosis.
4. The functional status of the liver in cases of portal cirrhosis, following portacaval anastomosis, is not decreased.

DISCUSSION

DR. LOUIS G. HERRMANN, Cincinnati: At the Cincinnati General Hospital we have also been interested in the various surgical methods for reducing hypertension in the portal circulation. Dr. Pattison has presented the indications for these surgical procedures, and he has given us an excellent summary of the results which he has obtained.

We have found that the anastomosis of the splenic vein to the renal vein in most patients with portal hypertension has been unsatisfactory. This has been due either to the technical difficulties of getting a long enough splenic vein to reach to the renal vein or, more often, to later thrombosis of the splenic vein at the site of the anastomosis.

In most of our patients the spleen has been found to be densely adherent to the diaphragm; consequently we adopted the thoracoabdominal approach to the spleen which Dr. B. N. Carter described many months ago. The illustration on the screen shows what an excellent exposure is obtained by this incision. The pedicle of the spleen is directly in front of the surgeon, and the adhesions to the diaphragm can be severed under direct vision.

More than a year ago we adapted this thoracic and abdominal incision to the right side in order to obtain an adequate exposure of the portal vein and the inferior vena cava at a point just below the liver. We believe that the portal circulation can be decompressed into the systemic venous circulation more effectively by a shunt between the portal vein and the inferior vena cava. Dr. Pattison has presented evidence that the portal vein can be completely severed and the entire portal circulation diverted into the vena cava without serious consequences. We have chosen to make a side to side anastomosis between the portal vein and the inferior vena cava so as not to divert completely the portal blood from the liver.

There are still many technical obstacles which must be overcome before the major hazards of the surgical treatment of portal hypertension can be considered as minimal. The portal vein has occasionally been found to consist of a group of small venous channels, so the blood could not be diverted into the systemic venous circulation by any surgical procedure.

Adequate exposure of all these structures is of paramount importance, so it is our hope that more surgeons will utilize the right thoracoabdominal approach in performing the anastomosis between the portal vein and the inferior vena cava. The ease with which the exposure can be accomplished should further reduce the hazards of this type of surgery.

DR. C. J. BERNE, Los Angeles: I have had the pleasure of watching Dr. Pattison's work. I think that in his report he had no intention of competing with various other procedures such as "packing" of the esophagus, gastric surgery and other types of portacaval anastomoses. I wish to make one point regarding portacaval anastomosis which he did not have time to cover:

(Slide) This comes close to being the crux of the real reason why complete division of the portal vein and anastomosis to the vena cava is physiologically possible, because the blood so shunted into the cava then reaches the same physiologic unit in the liver via the hepatic artery through the systemic circulation as that blood which has been previously going via the portal system into the sinusoid and in that way arrives at the same functional liver unit.

I believe that this particular point is the basis for all the various operations which have been attempted in creating these shunts. Dr. Pattison has had the privilege of reporting 10 cases of end to side anastomoses. Early, in watching these operations, it was my impression that the magnitude of the spontaneous portacaval anastomoses by the veins of Retzius in the region of the spleen and the left kidney was so great that the removal of these by splenectomy constituted almost as much of a deprivation in collateral as was added by a lienorenal shunt. For that reason the particular procedure which has been carried out was used.

The end to side anastomoses have been done by taking the button out of the vena cava, and I think that a larger connection than would be obtained with the ordinary incision anastomosis has been accomplished.

One of the important problems in diagnosis, left to be solved, has to do with the thrombotic problems incident to cirrhosis of the liver, in which subhepatic thrombosis of the portal vein has occurred in the past. As yet we have not come on any way, historically or otherwise, to recognize that previous thrombosis has occurred and therefore that the so-called cavernous transformation of the portal vein is existent.

The postoperative thrombotic complications, which have been more numerous in the group reported by Dr. Blakemore, fortunately have not yet occurred. I think it is an interesting phase of the problem and possibly is not related to ordinary thrombotic mechanisms but may turn out to have some relation to withdrawal of the splenic function or, rather, of the hypersplenism incident to portal hypertension and the withdrawal of these splenic overactivities and to the relation to the thrombocyte level in the blood during the early postoperative period when these thromboses occur. Studies in regard to this may be an interesting phase of the whole problem, because the secondary thromboses are generally considered to be one of the serious hazards in the operation.

DR. ARTHUR C. PATTISON, Los Angeles: In reference to Dr. Herrmann's discussion concerning the technical difficulty of this operation, may I make one comment? Our own experience has been that in that group of persons who have hemorrhage from esophageal varices the operation has been infinitely more easily done than in that group with ascites and for essentially two reasons: First, those who have hemorrhage from the esophageal varices do not seem to have the large

veins of Retzius communicating between the duodenum and the head of the pancreas and the liver. Second, those who have ascites have hypoproteinemia or hypoalbuminemia at the time they are operated on, and the edema makes that particular technical maneuver of elevating the duodenum and the head of the pancreas a little more difficult.

I might also stress the fact that, as Dr. Berne said, the establishment of a button, cut from the wall of the inferior vena cava to the size of the circumference of the portal vein, is extremely important for one other reason, and that is that by making a button in the inferior vena cava we feel (although we have no proof for it) that the incidence of thrombosis at the site of the anastomosis will be decreased.

USE OF HEPARIN AND DICUMAROL IN THE ACTIVE TREATMENT OF THROMBOEMBOLISM

JOHN H. OLWIN, M.D.
CHICAGO

ADVANCE in recent years in the knowledge of the blood coagulation mechanism and methods for its control has been a major stimulus to investigators in the field of thromboembolism. Reports of the reduction of its incidence postoperatively with the prophylactic use of anticoagulants¹ and the lowering of the mortality rates and complications in coronary thrombosis² have been encouraging. Once a thrombosis develops, the favorable effect of anticoagulants would appear to be a prevention of the spread of the lesion and of the formation of loose clots easily dislodged from the parent thrombus. In addition, recent work³ suggests an increase in the arterial blood flow from administration of dicumarol[®] and, to a less extent, heparin. There is evidence at present to indicate that the newly discovered prothrombin accelerator factor⁴ is increased early in the thrombotic process,⁵ and two groups of workers have found it to be depressed in the initial stages of dicumarol[®] therapy.⁶ It is the purpose of this paper to report experience with the use of heparin and dicumarol[®] in the active treatment of thromboembolism, more particularly the surgical conditions of thrombophlebitis and phlebothrombosis and of embolism, pulmonary and peripheral. In addition, attention is invited to the more accurate methods for

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From the Department of Surgery, Presbyterian Hospital of the City of Chicago, affiliated with the College of Medicine of the University of Illinois.

1. Barker, N. W.; Cromer, H. E.; Hurn, M., and Waugh, J. M.: *Surgery* **17**:207, 1945.

2. Wright, I. S., and Foley, W. T.: *Am. J. Med.* **3**:718, 1947.

3. Gilbert, N. C., and Nalefski, L.: *Proc. Central Soc. Clin. Research* **21**:5, 1948.

4. Fantl, P., and Nance, M.: *Nature, London* **158**:708, 1946. Owren, P. A.: *Acta med. Scandinav.*, 1947, supp. 194. Ware, A. G.; Guest, M. M., and Seegers, W. H.: *J. Biol. Chem.* **169**:231, 1947.

5. (a) Olwin, J. H.: Unpublished data. (b) Owren, P. A.: Personal communication to the author.

6. Fahey, J. L.; Olwin, J. H., and Ware, A. G.: *Proc. Soc. Exper. Biol. & Med.* **69**:491, 1948. Olwin, J. H.: To be published. Owren.^{5b}

controlling anticoagulant therapy, particularly the effects of dicumarol.⁶ Time does not permit a comparison of the results of this type of therapy with the results of other methods.

PRESENT STUDY

The present study is based on a series of 67 patients with peripheral phlebothrombosis or thrombophlebitis and 21 patients with embolism treated with dicumarol,⁶ 47 of whom also received heparin initially. Of the emboli, 17 were pulmonary, 2 involved vessels in the extremities and 2 were cerebral. One of the patients with a cerebral embolus also had embolization of the vessels in the extremities.

TABLE 1.—*Anticoagulant Therapy in Phlebothrombosis and Thrombophlebitis*

	Number of Cases	Pulmonary Emboli		Fatal Pulmonary Emboli		Absence of Residual Signs		Patients Lost
		No.	Per Cent	No.	Per Cent	No.	Per Cent	
Phlebothrombosis.....	45	1	2.2	0	0	39	86.6	2
Thrombophlebitis.....	22	0	0.0	0	0	17	77.2	1
Total.....	67	1	1.5	0	0	56	83.5	3

TABLE 2.—*Anticoagulant Therapy in Cases of Embolism*

	Number of Cases	Cases in Which Emboli Developed After Therapy Was Controlled		Mortality
		Number	Per Cent	
Pulmonary embolism.....	17	1	5.8	0
Peripheral embolism.....	3	0	0.0	0
Cerebral embolism.....	2	0	0.0	0
Total.....	22	1	4.7	0

HEPARIN AND DICUMAROL AND METHODS FOR CONTROLLING THEIR EFFECTS

Heparin is a rapidly acting drug and, according to present day concepts, depends for its chief effect on the inhibition of the conversion of prothrombin to thrombin. The role of the prothrombin accelerator may be important in this process.⁷

Dicumarol⁶ acts more slowly, requiring a minimum of forty-eight hours to achieve therapeutic effect, and its action is attributed to a depression of prothrombin formation. It would seem reasonable, there-

7. Owren, P. A.: Proc. Norwegian Acad. Sc., 1944.

fore, that efforts toward controlling the effects of both drugs might well be directed toward an accurate control of the active prothrombin level.

The common means for controlling heparin therapy has been a control of the coagulation time of whole blood. Because both the therapeutic and the safety ranges are rather broad, this has been reasonably satisfactory. The chief advantage of the test lies in its ease of performance. In different or even in the same hands, however, it is subject to unpredictable and unexplained variations, and its use is not without danger. Dosage of heparin in this study has been controlled by regulation of the measurable prothrombin level, and, as will be shown later, this factor is believed to be a more accurate reflection of heparin effect than is the coagulation time of the whole blood.

It is generally conceded that the only satisfactory control for dicumarol[®] effect is the estimation of the prothrombin level. Most hospitals rely on the one stage method of Quick⁸ or modifications of it for the estimation of this factor. Because of the several uncontrolled factors other than prothrombin,⁹ the test has led to errors in prothrombin estimation and may have been responsible for fatal hemorrhages from the use of dicumarol.[®] The two stage method described by Warner, Brinkhous and Smith¹⁰ and recently modified by Seegers¹¹ has given more uniformly accurate results and has been the guide for dicumarol[®] therapy in this series of cases. With this method it has been possible to reduce the prothrombin to the generally approved range of 10 to 30 per cent and, with few exceptions, maintain that range over a period of months or years if desired.^{5a} It is also possible with this method to carry on outpatient therapy with safety (fig. 1).

ROUTINE OF THERAPY

When a diagnosis of thrombophlebitis or phlebothrombosis is made, the patient's prothrombin level is determined, and if it is in the neighborhood of 100 per cent, i. e., 85 to 105 per cent, he is given 300 to 400 mg. of dicumarol[®] by mouth, depending on the prothrombin level and his weight. The following day he is given 200 mg. At the time of the first dose 50 to 70 mg. of heparin is injected by vein, and fifteen to thirty minutes later another determination of prothrombin is made. A level of approximately 35 per cent is sought, and the dosage of heparin

8. Quick, A. J.: *J. A. M. A.* **110**:1658 (May 14) 1938.

9. Olwin, J. H.: *Am. J. M. Sc.*, to be published.

10. Warner, E. D.; Brinkhous, K. M., and Smith, H. P.: *Am. J. Physiol.* **114**:667, 1936.

11. Seegers, W. H., in *Trans. First Conference on Blood Clotting and Allied Problems*, New York, Josiah Macy, Jr. Foundation, 1948.

is adjusted accordingly. The adjusted dosage is repeated every four hours until the dicumarol® effect is established.

The prothrombin level is determined on the third morning. It must be borne in mind that the effects of a single intravenous dose of heparin ordinarily persist for from four to six hours, and blood for estimation of the dicumarol® effect must be drawn at least six hours after the last intravenous dose of heparin (fig. 2). If the dicumarol® has not reduced the prothrombin to therapeutic levels at the end of forty-eight hours, supplemental injections of heparin in reduced amounts may be given until such effect is achieved. Subsequent doses of dicumarol® depend

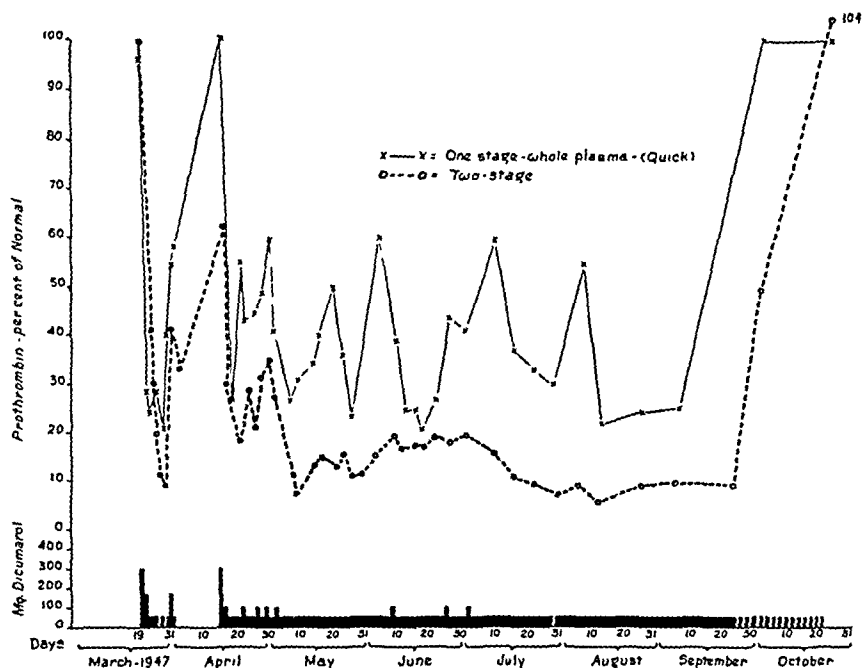


Fig. 1.—Comparative levels of prothrombin with one stage and two stage methods. This chart represents the course of therapy of a patient with thrombophlebitis of the leg which developed after minor trauma. When his prothrombin reached therapeutic levels, his condition improved and he elected to discontinue taking dicumarol. His signs returned when his prothrombin approached normal levels, and he was again placed on anticoagulant therapy. Because of continued slight swelling of the leg, he was maintained on dicumarol over a period of months, at the end of which time his leg appeared normal. He carried on normal office routine during the last six months of the therapy. Note the uniformity of the prothrombin estimations as shown by the two stage test and the wide variations in the one stage results. Had the latter been guiding the therapy, serious bleeding might have occurred and the prothrombin would not have been therapeutically controlled.

on the prevailing prothrombin level, and after the first four days of therapy determinations are usually made every other day and eventually once a week. In some patients who have been on therapy for over two years for other conditions estimations are made twice monthly.

Patients are kept in bed until the prothrombin is controlled, and in the case of phlebothrombosis they are then allowed up. If edema is present, an elastic stocking is provided. Those with the picture of thrombophlebitis are kept in bed until the more acute symptoms and signs subside and are then allowed to be up. The latter patients receive warm, moist dressings in the acute stages. Ligation of veins or sympathetic block has not been used. The use of dicumarol® is continued and the prothrombin maintained at therapeutic levels for one to three weeks after all signs have disappeared or until no further improvement is apparent. The minimum time of therapy has been two weeks, the maximum eight months and the average four to six weeks.

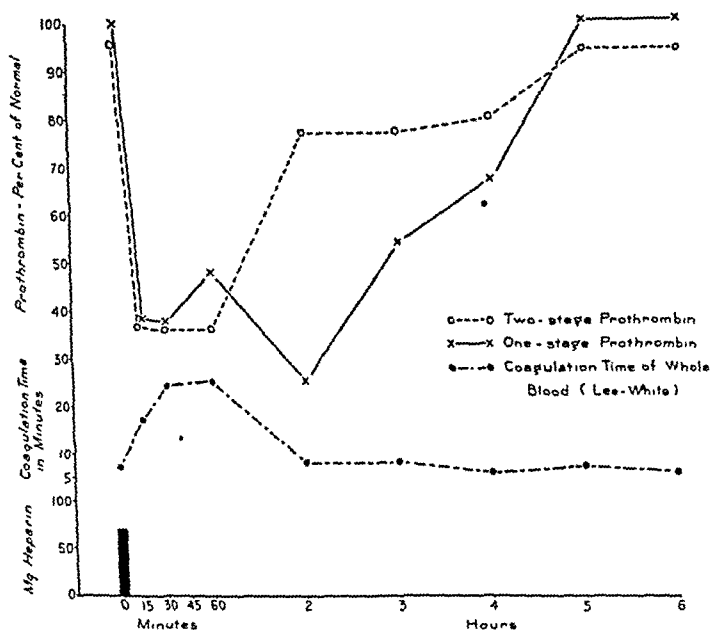


Fig. 2.—This chart represents the response of a patient to a single dose of heparin as shown by the prothrombin levels and the coagulation time of the whole blood. Note that the latter shows a return to normal after two hours, whereas the prothrombin remains somewhat depressed as long as four hours after the heparin injection. Prothrombin estimation is considered a more sensitive and uniformly accurate reflection of the effect of heparin than is the coagulation time of whole blood.

The program for cases with embolism is the same as that described with the exception that the prothrombin level is not obtained prior to the administration of heparin in acute cases. A large dose (70 to 100 mg.) of heparin is given through the same needle used for drawing blood and as rapidly as possible after the embolus occurs. Patients with embolism are allowed out of bed as soon as the prothrombin level is controlled, if other conditions permit.

RESULTS

In the 45 patients with phlebothrombosis the usual duration of signs and symptoms was one to two weeks. In no patient did the full blown picture of thrombophlebitis develop. In 7 nonfatal pulmonary emboli had developed before administration of anticoagulants was started. Of the latter, 6 had no further embolic episodes. One patient suffered a nonfatal embolism after he was on controlled therapy. Another patient, in addition to the 7, had twice recovered from episodes of cerebral thrombosis and thirty-four days after discontinuation of the use of anticoagulants suffered a fatal pulmonary embolus at home from an unrecognized pelvic phlebothrombosis. Thirty-nine (86.6 per cent) of the 45 patients with phlebothrombosis had no residual signs after the passing of the acute episode. Two died of other causes and hence could not be followed, 2 are lost from observation and 1 had residual swelling.

Twenty-one patients had what was considered thrombophlebitis of the leg, arm or, in 1 instance, large veins of the abdominal wall. In 7 it involved only the superficial vessels. In 1 of them extension to the deep vessels developed after controlled anticoagulant therapy was established. A nonfatal pulmonary embolus developed in 1 patient with thrombophlebitis prior to the beginning of anticoagulant therapy and in none after it was started. Of the 22 patients with thrombophlebitis, 17 (77.2 per cent) had no residual signs after the acute phase subsided, 1 died of generalized carcinomatosis and hence could not be followed, 1 is lost and 3 have residual swelling. In general, the earlier administration of anticoagulants was started the shorter was the course of the disease (fig. 3).

Seventeen patients in this study were treated after the development of pulmonary emboli. The source of the emboli in 9 cases was phlebothrombosis and in 1 case thrombophlebitis, and in 6 cases they were considered cardiac in origin. (The patients in 4 of these cases had auricular fibrillation.) In 1 case the source of the embolus was undetermined.

One patient suffered one embolus after anticoagulant therapy was established. None of the emboli was fatal. One patient with both phlebothrombosis and anterior and posterior myocardial infarctions ceased having emboli when anticoagulant therapy was established. He died at home thirty-four days after the use of dicumarol[®] was discontinued from what appeared to be a cerebral embolus.

In 2 patients with auricular fibrillation cerebral emboli with hemiplegia developed, and of these, 1 also had embolization of the left axillary and the right brachial arteries. She was in coma for six days. Recovery has been progressive, however, and at the present time (six months after the use of anticoagulants was started) her speech and

the circulation and function of both arms have returned to normal. The patient walks with the aid of a cane, though the leg still shows about 30 per cent loss of function. The other patient has shown about 30 per cent improvement after three weeks of anticoagulant therapy.

Two patients with bacterial endocarditis and peripheral emboli had no further embolism while given anticoagulant therapy.

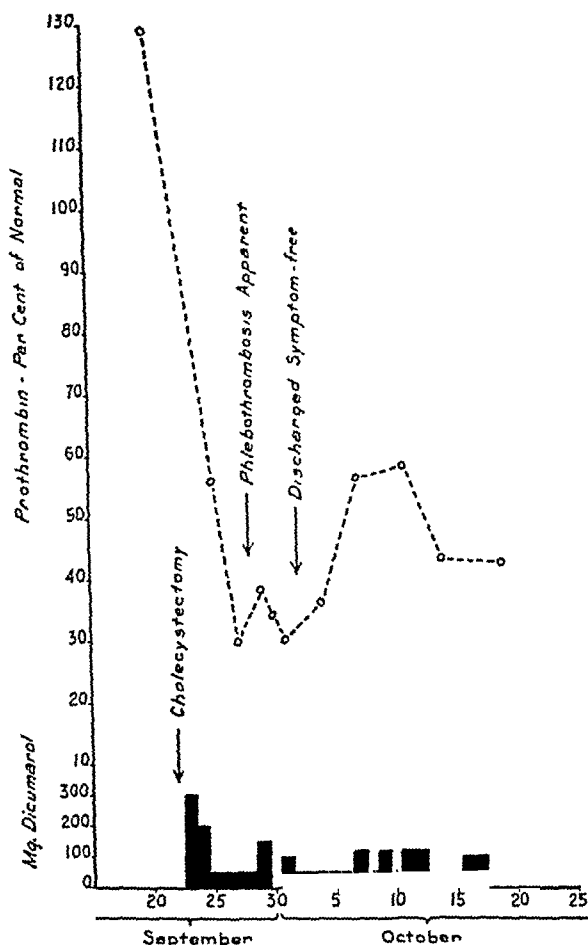


Fig. 3.—This chart shows the possible advantage of early institution of anticoagulant therapy. Because the patient represented had a prothrombin level of 129 per cent, even though there is no consistent correlation between an increased prothrombin level and intravascular clotting, administration of dicumarol was started on the second day after cholecystectomy. Four days later, at which time the prothrombin was considered controlled, swelling of the left leg and tenderness of the calf developed. The thrombus had no doubt been forming since the operation. All signs and symptoms had disappeared five days later, and the use of dicumarol was discontinued after fifteen additional days.

BLEEDING HAZARD

The two stage determination being a highly accurate measure of prothrombin concentration, the bleeding hazard is minimized. In this series bleeding occurred in 7 cases (9.4 per cent), the most common

site being the urinary tract. Withdrawal of the drug will in many instances allow the prothrombin to rise to nonbleeding levels. Administration of vitamin K intravenously in doses of 24 mg. every two hours for three doses will usually result in a prompt rise in prothrombin. Moderate to severe hepatic damage, blood dyscrasias and pathologic changes in the kidney may be relative contraindications to the use of dicumarol,[®] and in such instances vitamin K may have little effect on the prothrombin level.

SUMMARY

Sixty-seven patients with phlebothrombosis or thrombophlebitis and 21 with embolism, a total of 74 patients, were treated with dicumarol,[®] and in 47 of the cases heparin was used initially. The early disappearance of signs and symptoms, the low incidence of complications and the absence of mortality recommend this type of therapy for further trial.

The accurate control of the effects of the two drugs is important. The methods in common use at the present time are considered inadequate both from the point of view of the maintenance of an effective therapeutic level of prothrombin and from the standpoint of safety.

DISCUSSION

DR. DON H. O'DONOGHUE, Oklahoma City: There are two things Dr. Olwin can help me with. In most of our cases thromboembolism occurs after rather massive orthopedic operations, such as disk and fusion or major operations on the hip. The other situation, in which we run into thrombophlebitis particularly, is in massive crushing injuries. The sites of both of these operations, as you can see, are places where it is difficult to have good hemostasis either post-operatively or post-traumatically.

In most instances the condition comes on seven to ten days, and even later, after surgical intervention. I should like to be informed as to whether this procedure of lowering the level to 10 to 35 is safe in these cases or whether one is likely to get serious hemorrhage after the administration.

DR. JOHN H. OLWIN, Chicago: I think it depends entirely on the method of control. I believe our fatal accidents from hemorrhage have been a result of inadequate methods for controlling the coagulation factors.

The two stage method of Warner, Brinkhous and Smith, more recently modified by Seegers, is described completely in the "Transactions of the First Conference on Blood Clotting and Allied Problems," published by the Josiah Macy, Jr. Foundation, 565 Park Avenue, New York. It is more complicated than the one stage method, but it seems to me that the results are well worth the trouble required in setting it up.

Also, perhaps it is of interest to you that the reagents for this test are expected to be available commercially before long and will make the test considerably more simple to perform.

We have used this method of therapy within a few hours after a major surgical procedure, and in no instance have we had any serious hemorrhage. Using this method for control, we have had hemorrhage in about 10 per cent of all our

cases in which anticoagulant therapy was used, which now number about 200. This is usually from the urinary tract and may be microscopic or gross, lasting perhaps one to seven days depending on the therapy. Occasionally there is excessive bruising, some nasal bleeding, some bleeding from the gums and occasionally some hematomas intramuscularly.

Because we feel that the prothrombin level is always known and the patient is never far below his bleeding threshold, we have not been concerned about minor hemorrhage. Except in certain cases of hepatic or renal dysfunction or in certain blood dyscrasias, the prothrombin will return rather promptly to normal within a few hours after large doses of vitamin K are given. I would say that this should apply to orthopedic operations as well as to general ones.

DIAGNOSIS AND SURGICAL TREATMENT OF PATENT DUCTUS ARTERIOSUS

WILLIS J. POTTS, M.D.

STANLEY GIBSON, M.D.

SIDNEY SMITH, M.D.

AND

WILLIAM L. RIKER, M.D.

CHICAGO

AT BIRTH the patent ductus arteriosus has fulfilled its function and should obliterate itself. Various reasons have been presented for its failure to close, but none have been convincing. Why so few ducti remain permanently open seems a more reasonable question. Why should a large endothelium-lined tube between vessels carrying different intraluminal pressures close? Until further evidence is gained all we can do is lamely ascribe the tendency toward spontaneous closure to the fundamental characteristic of the tissue.

Many ducti do not close promptly at birth. Christie¹ has pointed out that 44 per cent are still open at 1 month of age, 12 per cent at 2 months of age, 2 per cent at 8 months and approximately 1 per cent at 1 year of age. A few ducti close spontaneously between the first and second years of life. It is generally assumed that a ductus which is open at 2 years of age will remain permanently patent.

In a typical case uncomplicated by other cardiac abnormalities a diagnosis of patent ductus arteriosus can be made almost without error. The outstanding all-important physical finding is the classic "humming top" or "machinery" murmur. It is usually heard best at the second left interspace anteriorly. The murmur is continuous, going all the way through systole and diastole. In fact, if the murmur does not go all the way through diastole the patient very likely does not have a typical patent ductus arteriosus. Taussig said:² "The absence of a continuous murmur is strong contraindication for operation. With

From the Children's Memorial Hospital.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 2, 1948.

1. Christie, A.: Normal Closing Time of the Foramen Ovale and the Ductus Arteriosus, *Am. J. Dis Child.* 40:323 (Aug.) 1930.

2. Taussig, H.: *Congenital Malformations of the Heart*, New York, The Commonwealth Fund, 1947, p. 349.

the possible exception of a subacute bacterial endocarditis, operation should never be considered in the absence of a continuous murmur over the base of the heart."

In this series of 52 cases the diagnosis was confirmed at operation in every case. Two patients had raucous systolic murmurs which had a slight carry-over into diastole. These patients were carefully studied

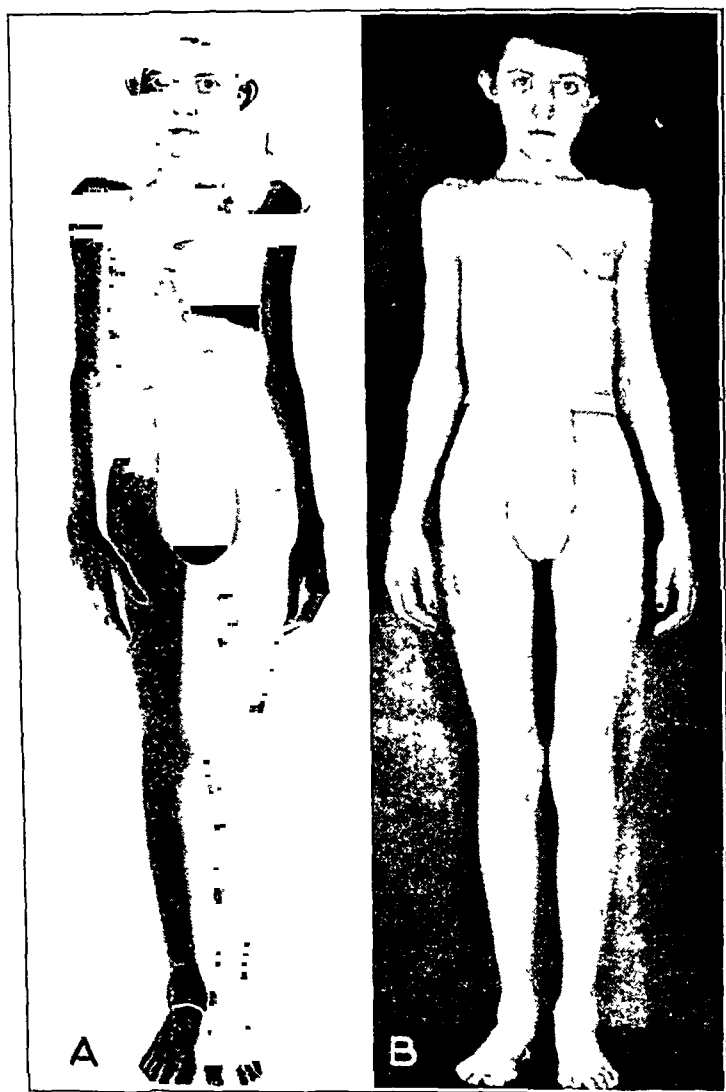


Fig. 1.—A, B. C., aged 13 years and weighing 65 pounds (29.5 Kg.), on the verge of heart failure, was operated on on Feb 7, 1947. The ductus was huge, 18 mm. in diameter (outside measurements). B, the patient gained 22 pounds (10 Kg.) during the first two months following operation (see fig. 2).

by a number of cardiologists, and 1 patient was subjected to catheterization of the heart. Our conclusion in both cases was that an arteriovenous shunt existed but probably not a typical patent ductus. At operation

the findings in both were identical. There was no patent ductus but an abnormal opening in the common wall of the aorta and the pulmonary artery just beyond their emergence from the ventricles. It was a

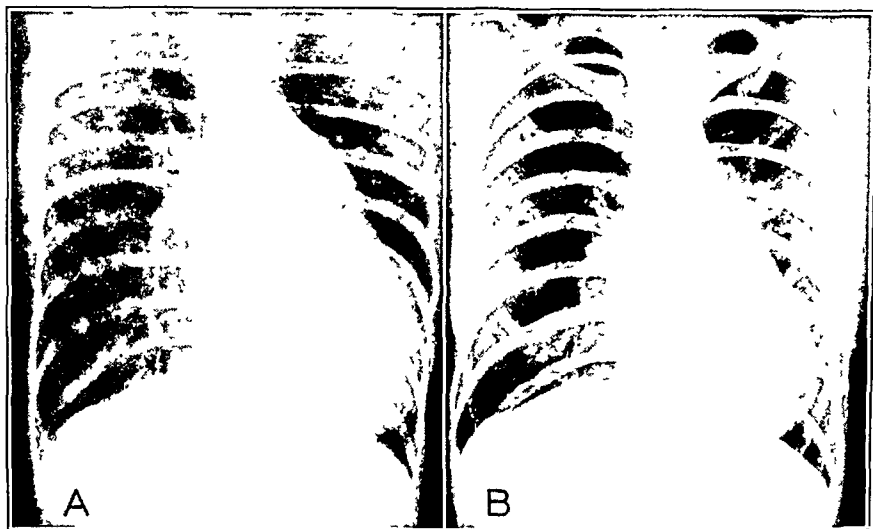


Fig. 2.—*A*, preoperative roentgenogram made on B. C. on Feb. 2, 1947, showing enlargement of the heart and marked dilatation of the pulmonary artery. *B*, roentgenogram taken on Nov. 13, 1948, twenty-one months after operation. In spite of normal physical growth and gain in weight the heart is smaller than before operation.

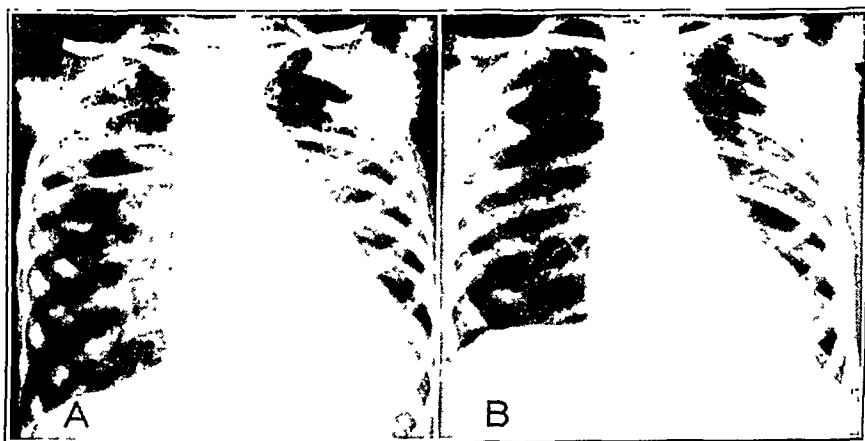


Fig. 3.—*A*, D. W., aged 4, weight 32 pounds (14.5 Kg.), height 41 inches (109 cm.), was operated on on Dec. 10, 1946. The outside diameter of the ductus was 12 mm. *A*, roentgenogram taken before operation shows cardiac enlargement and pronounced vascularity of the lung fields. *B*, this roentgenogram taken twenty-two months after operation shows that the heart is smaller than before operation. The vascularity of the lung fields had disappeared six weeks after operation.

temptation to attempt a suture closure of this opening. The hazard of such a hitherto untried procedure and the probability of the closure,

at best imperfect, being inadequate and tending to reopen made us regretfully abandon the idea.

Palpation of the chest over the left pulmonic area will often reveal a thrill which one child unprompted described as follows: "It feels like bees in a bag." The simile is excellent. The intensity of the thrill is roughly indicative of the size of the ductus.

The systolic blood pressure is usually normal, but the diastolic pressure is apt to be low—often in the vicinity of 30 to 50 mm. of mercury. Consequently there is a water hammer type of pulse, and a "pistol shot" can be felt over the femoral arteries. A capillary pulse can be seen in the lower lip pressed down firmly with a glass slide. This sign is far from infallible, because a similar pulse can often be seen in children whose hearts are normal.

If the patent ductus is large, physical development is frequently retarded (fig. 1). The height, but especially the weight, is apt to be subnormal. However, many of the children seem to be especially alert mentally and, so long as they are not impeded by heart strain, are hyperactive. This desire for constant activity has been observed often enough to suggest that it may have a cause.

A child with an uncomplicated patent ductus arteriosus is never blue.

In 3 of 52 patients there have been associated congenital cataracts. The mother in each instance had had rubella during the early months of pregnancy. This finding is significant in view of the attention that has been focused on rubella in the early months of pregnancy as a cause of certain congenital abnormalities.

Of the routine laboratory studies, the roentgenogram alone gives valuable information. The red blood cell count is normal. The electrocardiogram is regularly normal or may show a slight deviation of the axis to the left or right. If the ductus is small, the heart shadow is usually normal or nearly so. In patients who have a large ductus the heart is enlarged (fig. 2) and a bulge is seen at the region of the left base. This enlargement is due to dilatation of the pulmonary artery. Vascularity of the lung fields (fig. 3) due to excessive blood flow in the lesser circulation is seen in the roentgenogram, and a "hilar dance" can be seen fluoroscopically.

SURGICAL CONSIDERATIONS

Indications for operative closure of the patent ductus have slowly broadened as the mortality of surgical therapy has lessened. Most cardiologists today advise that all typical patent ducti be treated surgically. Even though the child has no symptoms and the condition is discovered incidentally, operation should be advised because of the risk

of eventual irremediable complications is greater than that of surgical intervention. It is not uncommon for a patient of middle age with a known patent ductus urgently to request operation because of rather sudden appearance of signs of heart failure. At this age the operative mortality is high and the operation is difficult, whereas in children the mortality is low and the operation when mastered is not too difficult. With each decade the ductus becomes shorter, adhesions about it more dense, the walls more rigid and friable and consequently the danger of uncontrollable hemorrhage greater. Operation is therefore advised for all typical patent ducti in children between the ages of 2 and 12 years.

Cardiologists advise surgical treatment, but surgeons are not in agreement as to the best method of obliterating the ductus. Originally Gross³ employed simple ligation, but as experience increased and recurrences presented themselves he advised division and suture. At present he severs all patent ducti.⁴ Blalock,⁵ on the contrary, stated the belief that ligation is the treatment of choice. Shapiro and Johnson⁶ studied 643 patients who underwent operation for patent ductus by 46 surgeons. In 525 the ductus was uninfected, in 101 it was infected and in 17 the diagnosis was erroneous. The mortality rate in cases of noninfection was 4.9 per cent, and the rate of recurrence was 8.7 per cent. They concluded: "Ligation of the ductus is now obsolete and should be done only where section is impossible. That section of the ductus is a safe and practical procedure is established by the fact that 172 patients with uninfected patent ductus arteriosus have been so treated without a single fatality and no recanalization."

Gilchrist⁷ reported on a boy of 13 with a large ductus, 1 cm. long and 1 cm. broad, ligated with two double silk ligatures. A systolic murmur was detected three days after operation, and at seventeen days all local signs of a patent ductus arteriosus were again fully developed. He also cited moderate improvement in 2 cases in which the ductus was incompletely occluded by ligature.

From a survey of medical literature and from discussions by men of experience in the field of surgery of the ductus it appears that

3. Gross, R. E., and Hubbard, J. P.: Surgical Ligation of Patent Ductus Arteriosus: Report of First Successful Case, *J. A. M. A.* **112**:729 (Feb. 25) 1939.

4. Gross, R. E.: Complete Division of Patent Ductus Arteriosus, *J. Thoracic Surg.* **16**:314 (Aug.) 1947.

5. Blalock, A.: Operative Closure of the Patent Ductus Arteriosus, *Surg., Gynec. & Obst.* **82**:113 (Feb.) 1946.

6. Shapiro, M. J., and Johnson, E.: Results of Surgery in Patent Ductus Arteriosus, *Am. Heart J.* **33**:725 (May) 1947.

7. Gilchrist, R. R.: Ligation of Ductus Arteriosus, *Edinburgh M. J.* **53**:346 (July) 1946.

reconsideration of the question of ligation versus division is in order. A number of facts must, therefore, be considered: Incomplete occlusion of a ductus by an insufficiently snug ligature must be regarded as an operative failure; too tight ligation may result in hemorrhage at the time of operation or in recanalization later; it is generally agreed that infected ducti should be divided; the best principles of surgery are not employed when one buries large amounts of foreign material against large vessels and bronchi in children or adults; ligation appears to be an easier and safer procedure in the hands of most men; whether operative mortality is greater after division than after ligation is not definitely known; if the mortality is lower after ligation, does that justify poorer final results while waiting for time and experience to decide whether ligation or division of a patent ductus is the operative procedure of choice? At present, if compromise is permissible, this might be considered. A surgeon who has had adequate training and experience and who has familiarized himself with the handling of large vessels probably should employ the technic of proper ligation in his early cases. Surgery of the ductus is not easy, and even a surgeon with the stoutest nerves and the steadiest hands will fumble a bit in his first few cases. After he has developed confidence in his ability to dissect the ductus completely free and has convinced himself that he can properly suture a large vessel, then the hurdle of division and suture will not seem too high. Furthermore, it is well for the beginning surgeon to remember that surgery of the ductus is far less formidable in children than in adults.

Without question the only obstacle to universal acceptance of division and suture of a ductus is the well founded danger of uncontrollable hemorrhage due to slipping clamps. It appears that a recently developed ductus clamp employing a new principle may greatly lessen this danger.⁸ This clamp (fig. 4) has been used satisfactorily in the division of ducti in 30 consecutive cases. The principle of this clamp or forceps is embodied in rows of extremely fine teeth in apposing jaws. The teeth are approximately 1 mm. long and closely spaced—40 to 1 inch (2.54 cm.). The jaws of the clamp are about 1 mm. wide and hollow ground, so that they are less than 1 mm. wide at the base of the teeth. The hub of the clamp is so built that when the jaws are closed the teeth appose but do not interdigitate. The tiny teeth embed themselves in the adventitia of the vessel. In the experimental laboratories at Northwestern University these clamps were tested on large and small arteries and veins. It was demonstrated that they will occlude,

8. Potts, W. J.: A New Clamp for Surgical Division of the Patent Ductus Arteriosus, *Quart. Bull., Northwestern Univ. M. School* **22**:321 (Nov.) 1948.

will not slip and will not pierce or otherwise injure a vessel. Modified sizes and shapes of this clamp have been used satisfactorily for other types of surgery such as coarctation of the aorta, embolectomy and shunting operations for the relief of pulmonary stenosis.

SURGICAL TECHNIC

Although the technic of division and suture of a patent ductus has been described previously, a few details are worthy of emphasis (fig. 5).

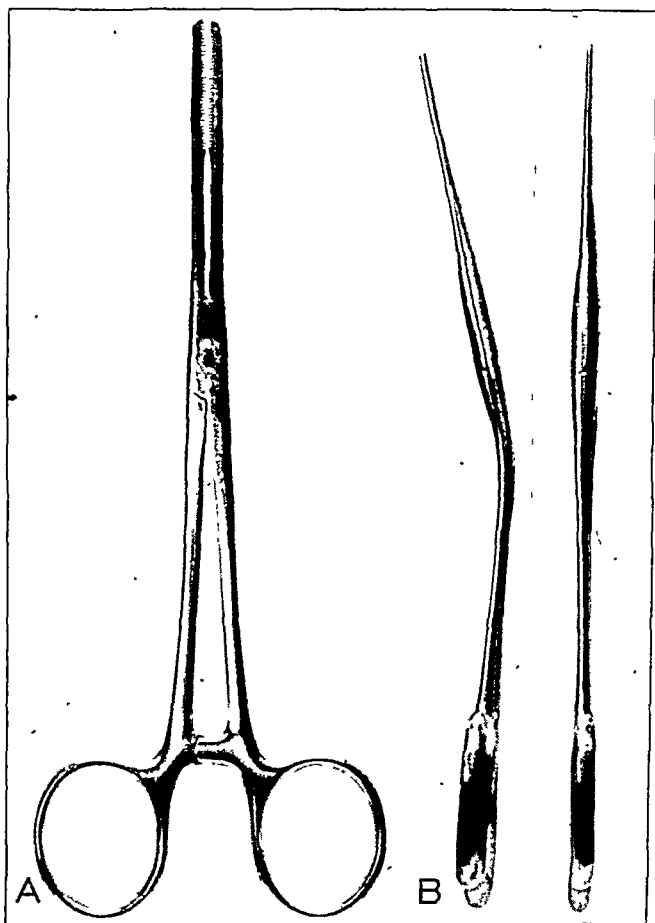


Fig. 4.—*A*, ductus clamp showing tiny teeth in apposing jaws. *B*, the angled clamp is placed on the aortic end of the ductus and the straight clamp on the pulmonary end.

We prefer a posterolateral incision through the left fourth interspace to the anterior submammary approach.

After the mediastinal pleura is opened, the fat, loose tissue and lymph glands lying on and about the ductus should be thoroughly removed. Constantly clear visualization of the field is an absolute essential. The vagus nerve and its recurrent laryngeal branch are

identified and retracted gently laterally. Cutting a few small obstructing branches of the vagus to the root of the lung seems to cause no ill effects.

The most important step in the operation is complete, thorough and painstaking dissection of the ductus. The lappet of pericardium overlying part or all of the ductus is grasped with a plain tissue forceps and with a scissors is dissected free. This dissection will be greatly simplified if it is made through the loose adventitial layers. It will be known that the dissection is being made through this layer if the

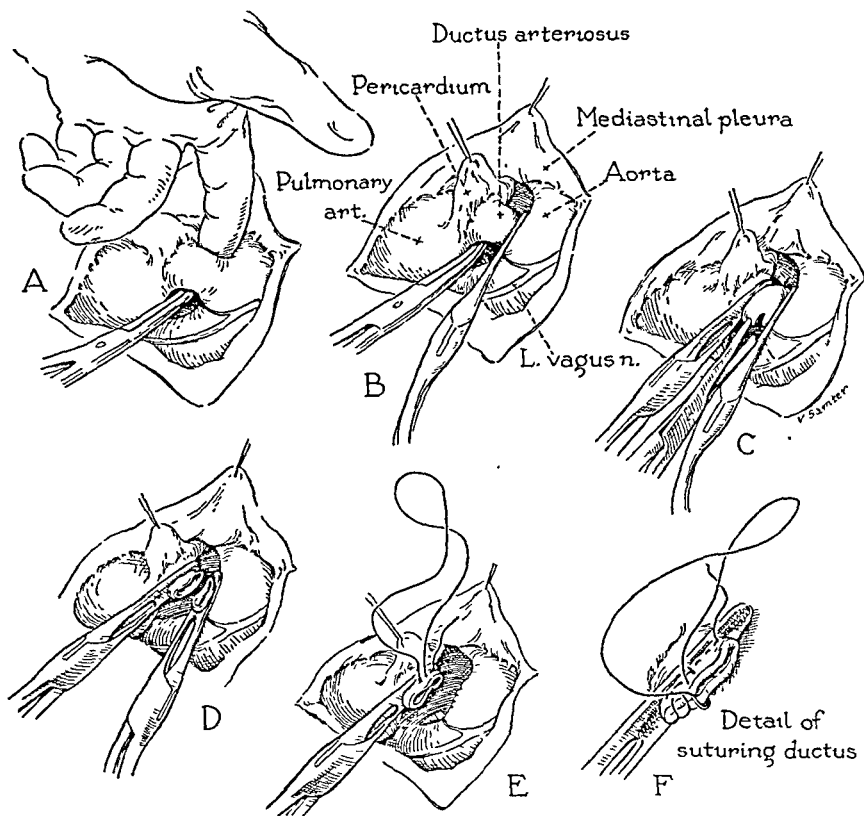


Fig. 5.—Technic of division and suture of patent ductus arteriosus.

gray-white wall of the ductus becomes visible. It cannot be too strongly emphasized that the lappet of pericardium overlying the ductus and the fibrous tissue about the ductus must be dissected completely free. After the ductus has been elevated from the underlying bronchus it is held up with a strip of umbilical tape so that the loose and fibrous tissue can be freed from its inferior surface also.

It will be discussed later under complications but the emphasis of repetition is justified—it is absolutely essential that the ductus be dissected free from all overlying loose tissue or any clamp will slip.

If a ductus is cleaned the teeth of the clamp will hold safely and surely in the wall. However, if the clamp is placed on the ductus in overlying loose tissue or if the pericardial fold is included in the clamp the cut ends of the ductus will tend to retract out of the jaws of the clamp. This danger is still greater when ordinary hemostats are used.

It is surprising how many ducti which at the beginning of dissection appear to be direct communications between the aorta and the pulmonary artery have a fairly reasonable length when dissection is complete.

The ductus is slightly elevated with a cystic duct forceps, and the ductus clamps are applied well on the aortic and pulmonary ends. These clamps must not be slid over the ductus or their edges will act as a saw. With the jaws wide open, the site of application is visualized and the clamp closed. Since the clamps are very thin, practically the entire length of the ductus, from 4 to 7 mm., lies between them. The ductus is cut and the stumps sutured with 5-0 Deknatel silk as illustrated in figure 5. The to-and-fro mattress suture followed by an over-and-over suture gives a nearer leakproof closure than a double row of continuous sutures.

After the aortic stump has been sutured, the clamp is partially opened to see if there will be any bleeding. The clamp is again closed in position and an extra stitch put in if necessary. The clamp is used rather than a retractor to hold the aorta out of the way while the pulmonary end is being sewed. Traction on the suture line in the aorta is thereby avoided.

Before closure we routinely place a snugly fitting catheter drain through the sixth interspace. This drain is connected with a water seal bottle after the patient is returned to bed and left in place two to three days. The advisability of using drains in such cases has been questioned. We have not had to aspirate the chest postoperatively and have had no infection in the chest or about the tube.

Postoperative care is routine. Penicillin in 100,000 unit doses is given twice a day for five to seven days. The patient is discharged from the hospital on the eighth to tenth postoperative day.

OPERATIVE AND POSTOPERATIVE COMPLICATIONS

Hemorrhage from the ductus during operation occurred four times in 52 operations. In the second patient operated on a hole was poked in the anterior wall of the ductus with a cystic duct forceps while the dissection was being done. We should have used scissors and followed the proper line of cleavage instead of trying to do blunt dissection. Hemorrhage followed too tight ligation in the fourth patient operated on.

In case 38 the pericardium was not sufficiently well dissected from the pulmonary end of the ductus. The clamps were applied and the ductus cut. While the aortic stump was being sutured the inferior edge of the pulmonary end of the ductus slowly rolled out of the lower end of the clamp. It was easily caught with a stitch, but the need of adequate clearing of the ductus before applying the clamps was a lesson vigorously taught. Hemorrhage in case 50 was caused by opening a small aneurysm on the posteroinferior border of the ductus, where visualization was poor. Clamps were placed on each side of the small opening and the ductus was cut and sutured satisfactorily.

Although the hemorrhage was severe in case 2, slight in the other 3 and controlled in all without much difficulty, in each instance there were anxious moments. Hemorrhage in the first 3 instances was due to faulty technic and in the fourth to an unexpected, previously undemonstrable, pathologic process.

The recurrent laryngeal nerve was injured in cases 2 and 4 through hasty and panicky application of hemostats to a bleeding ductus.

Postoperative complications have not been serious. Three children had postoperative atelectasis of the left lung; 2 recovered spontaneously, and the third recovered promptly after bronchoscopic aspiration. One child had pneumonia of the lower lobe of the left lung. Two children had severe tracheobronchitis, probably due to the irritation of intratracheal anesthesia. One of these children required tracheotomy. Urticaria in 1 patient was presumably due to penicillin sensitivity.

DISCUSSION

The size of the patent ductus, with one exception, varied from 4 to 12 mm. in diameter, with an average of 7.4 mm. These are outside measurements made with a caliper. Many ducti had the shape of a truncated cone, wide at the aortic end and tapering toward the pulmonary end. One patient (fig. 1) had a ductus actually measuring 18 mm. in diameter. This is the largest ductus of which record can be found. She was 13 years old and weighed 65 pounds (29.5 Kg.). Her heart (fig. 2) was enlarged and showed an unusually large convexity at the left base. Her chest heaved with each heart beat. She was on the verge of cardiac failure. She gained 22 pounds (10 Kg.) in weight during the first two months following operation.

As would be expected, after closure of a ductus in a child with cardiac enlargement the heart retains its size until body growth catches up with it. In a few patients who had considerable enlargement of the heart at the time of operation and who were, in fact, at the brink of heart failure, the size of the heart is smaller now than it was two years ago, before operation.

Mortality is a perilous subject to discuss. A well known surgeon lamented his expressed pride in 150 consecutive operations on the gallbladder performed without a fatality. The next 2 patients died. The mortality rate for surgery of the ductus, especially in children, is and should remain low. In this series of 52 cases there has been no death. All the patients were between 2 and 13 years of age.

SUMMARY

Diagnostic features of patent ductus arteriosus are presented. Importance of the characteristic continuous murmur is emphasized. The subject of ligation or division and suture of the ductus is discussed. It is believed that by use of a recently described ductus clamp embodying a new principle the danger of uncontrollable hemorrhage can be lessened. In this series of 50 consecutive cases, 20 ducti were ligated and 30 ducti were divided and sutured. There were no deaths.

REPAIR OF DEFECTS IN ETHMOID AND FRONTAL SINUSES RESULTING IN CEREBROSPINAL RHINORRHEA

ALFRED W. ADSON, M.D.

AND

ALFRED UIHLEIN, M.D.

ROCHESTER, MINN.

THE PURPOSE of this contribution is to call attention to the etiologic factors responsible for the spontaneous development of cerebrospinal rhinorrhea and the methods employed in closing defects in the cribriform plate of the ethmoid bone which were congenital in origin or the result of bullet wounds and to review the results of our surgical experiences in treating cerebrospinal rhinorrhea.

CAUSATION

Cerebrospinal rhinorrhea may result from a number of causes, the most common of which is skull fracture that extends through the posterior wall of the frontal sinus (fig. 1) or the cribriform plate of the ethmoid bone, with accompanying tears of the dura and arachnoid.¹ The first evidence of rhinorrhea associated with fracture of the skull is the occurrence of a watery, bloody discharge from the nose. In most instances, in our experience, the lesions heal, with spontaneous remission of the rhinorrhea. Persistent rhinorrhea or its delayed occurrence usually is due to considerable loss of bone, absorption of a fragment of bone or inclusion of the dura and arachnoid between fragments of bone permitting escape of cerebrospinal fluid into one of the nasal cavities. Cerebrospinal rhinorrhea frequently has occurred spontaneously as the result of a congenital defect in the cribriform plate which permits extension of an envelope of dura and arachnoid along an olfactory nerve fiber through the cribriform plate. In such cases leakage of cerebrospinal fluid undoubtedly is the result of rupture of the thinned-out arachnoid and mucous membrane. According to reviews in the literature, precipitation of this type of rhinorrhea usually is the result of coughing or sneezing during an attack of head cold. Rhinorrhea has accompanied hydrocephalus, and in the particular instance

From the Section on Neurologic Surgery, Mayo Clinic.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 2, 1948.

1. Brody, B. S.: *J. Mt. Sinai Hosp.* 5:444, 1938. Gupta, N.: *Indian M. Gaz.* 71:264, 1936.

leakage of cerebrospinal fluid was the result of increased intracranial pressure on thinned-out membranes and absorptive defects of the cribriform plate. We have also seen the condition afflict 2 patients suffering from pituitary tumor. The floor of the sella turcica had been absorbed, with presumable leakage of cerebrospinal fluid into the sphenoidal sinus. We also observed the condition in a patient who had a large osteoma of the orbit which had extended through the ethmoid into the anterior fossa. Rhinorrhea has followed the removal of nasal polyps. The polyps were meningoceles that had extended through the cribriform plate. Rhinorrhea also has resulted from craniotomy when, in the making of the anterior margin of the bone flap, the frontal sinus was unintentionally opened.

SYMPTOMS AND SIGNS

The only symptom that many patients complain of is an annoying, watery discharge of the nose. It may be continuous, or it may cease for

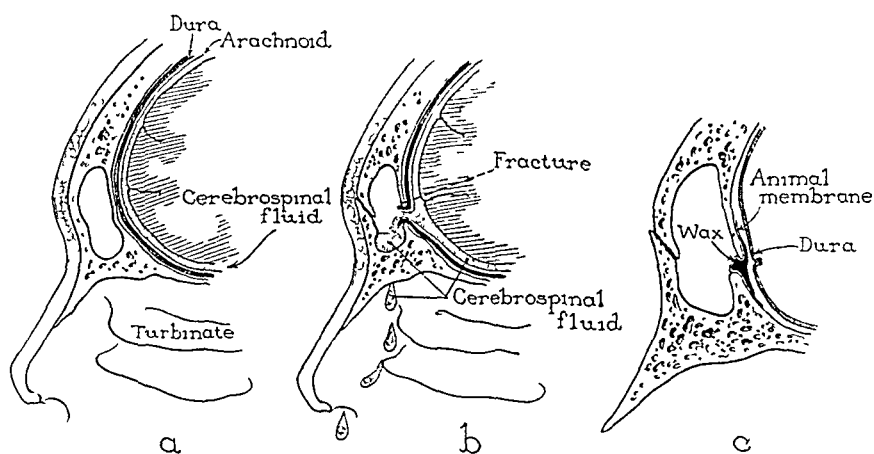


Fig. 1.—*a*, normal relationships of the brain, meninges and skull in the frontal region; *b*, craniosinusal fistula, with leakage of cerebrospinal fluid into the frontal sinus and thence into the nose; *c*, plastic closure of the meninges and occlusion of the bony defect with wax.

only a few hours and then resume. The discharge may appear as drops of clear fluid, or it may pour out in a stream when the head is tilted in certain positions. Usually, it appears in one side of the nose and produces the sensation that is experienced when the nose is congested. In cases of acute injury of the head, it may be difficult to recognize cerebrospinal fluid because it is mixed with blood, but when the condition is chronic the fluid is watery and can be readily collected and examined chemically. Cerebrospinal fluid is colorless, limpid and slightly viscous, has a specific gravity of 1.004 to 1.008 and contains traces of protein and small quantities of inorganic salt and dextrose. The lymphocyte count varies from 5 to 10 cells per cubic millimeter of

fluid. If there is doubt about the presence of cerebrospinal fluid in a discharge from the nose, the indigo carmine test, in which 1 cc. of indigo carmine is introduced into the subarachnoid space of the spinal canal by means of routine spinal or cisternal puncture, might be employed. Since the dye promptly stains the cerebrospinal fluid a bluish green color, it will be seen to appear in the nasal discharge within about fifteen minutes and will continue for two or three hours if fluid discharging from the nose contains cerebrospinal fluid. This test is of particular value in the differentiation between cerebrospinal rhinorrhea and allergic or vascular rhinorrhea. Roentgenologic examination of the skull offers some aid in the diagnosis in cases of recent fracture, but rarely is such examination of much assistance in the localization of cerebrospinal fistula involving the ethmoid cells.

Meningitis is the serious complication which may accompany this condition. It occurs more often when rhinorrhea results from fracture of the skull than it does when rhinorrhea occurs spontaneously, but it is a constant threat in all cases, and especially so when the patient has contracted a nasopharyngeal infection. Fortunately, chemotherapy has proved of value in combating meningitis and also has made it possible to perform these extensive operations without fear of the development of this complication.

CONSERVATIVE TREATMENT

Conservative treatment (nonoperative) often has been employed by those who feared to advise or employ the radical procedure designed to close the fistulous tract. The argument set forth by those who advocate conservative treatment is that they believe it safer not to disturb the patient than it would be to hazard a radical operation. Unfortunately, there is little to offer in the way of nonoperative treatment. Fox,² and Friedberg and Galloway³ reported 2 cases in which spontaneous cerebrospinal rhinorrhea was controlled by the application of a 20 per cent solution of silver nitrate to the polypous area of the nose. Fox identified the opening through the cribriform plate by the use of indigo carmine, after which he applied the solution of silver nitrate several times, with apparent recovery of the patient. Friedberg and Galloway stated that they observed the cerebrospinal fluid entering the nasal cavity at a point at which the anterior third portion of the middle turbinate bone joins the middle third portion of this bone, at which point they applied a 20 per cent solution of silver nitrate. The discharge ceased within twelve days, and at the time of the report the patient had been free of rhinorrhea for fourteen months.

2. Fox, N.: Cure in Case of Cerebrospinal Rhinorrhea, *Arch. Otolaryng.* 17:85 (Jan.) 1933.

3. Friedberg, S. A., and Galloway, T. C.: *Ann. Otol., Rhin. & Laryng.* 47:792, 1938.

Conservative treatment is of definite value in cases of acute rhinorrhea accompanying fracture of the skull, since a number of the meningeal defects will heal spontaneously. Teachenor,⁴ Dandy,⁵ Cairns,⁶ Munro⁷ and Coleman⁸ have advocated surgical repair of the meninges if rhinorrhea does not disappear within four to six days after the time of injury. The approach employed is a transfrontal sinus approach in which the dura is exposed at the point of injury. Teachenor has suggested removal of the posterior wall of the frontal sinus, along with craniotomy. Lesions involving the ethmoid bone and the overlying meninges have been dealt with more conservatively than this in cases in which the condition is acute. However, Coleman⁸ has employed unilateral frontal craniotomy in repair of recently injured meninges over the ethmoid bone. It has been our experience that if spontaneous recovery from cerebrospinal rhinorrhea is to take place after fracture of the skull it may not do so for an interval extending from a few days to eight weeks, and, therefore, it has been our practice to limit the intake of fluid to 1,500 cc. per day, in order to decrease the output of cerebrospinal fluid, and to administer penicillin and sulfanilamide or sulfathiazole in doses of 60 to 90 grains (4 to 6 Gm.) per day until the concentration of sulfanilamide in the blood registers from 8 to 12 mg. per hundred cubic centimeters. Also, we have found it advantageous to have the patient remain in bed in a semierect posture, making sure that he sleeps in the same position, since this minimizes the flow of cerebrospinal fluid into the nose. In the event that conservative measures fail to effect spontaneous remission of the rhinorrhea, we should advise the procedure developed by one of us (Adson⁹).

SURGICAL TREATMENT

Although fractures of the skull are common, in only a relatively small group of cases does cerebrospinal rhinorrhea develop. In 940 cases of trauma of the head which Coleman⁸ reviewed, "there were 216 fractures of the skull, with eighty-seven fractures of the base. Of the eighty-seven basal fractures, fifteen involved the frontal sinuses; six of these were associated with severe compound, depressed fracture of the frontal vault and operation was promptly done for disinfection,

4. Teachenor, F. R.: Intracranial Complications of Fracture of Skull Involving Frontal Sinus, *J. A. M. A.* **88**:987 (March 26) 1927.

5. Dandy, W. E.: Pneumocephalus, *Arch. Surg.* **12**:949 (May) 1926.

6. Cairns, H.: *J. Laryng. & Otol.* **52**:589, 1937.

7. Munro, D.: *New England J. Med.* **213**:893, 1935.

8. Coleman, C. C.: Fracture of Skull Involving Paranasal Sinuses and Mastoids, *J. A. M. A.* **109**:1613 (Nov. 13) 1937.

9. Adson, A. W.: *Proc. Staff Meet., Mayo Clin.* **16**:385, 1941. *Ann. Surg.* **114**:697, 1941.

débridement and closure of the dura." Coleman's observations are similar to those of others. The incidence of rhinorrhea after fracture of the skull varies from 2 to 5 per cent. In view of the fact that rhinorrhea sometimes is spontaneously cured, we are inclined to wait six or eight weeks before advocating repair of the craniosinusal fistula unless the fracture is compound and involves both walls of the frontal sinus.

The previously accepted procedures for closure of craniosinusal fistulas which communicate with the frontal sinus, the ethmoid cells and the nasal cavity have been (1) in cases in which the condition is acute, surgical repair through the frontal sinus; (2) in cases in which the condition is chronic and it is possible to identify the site of the lesion, performance of small unilateral transfrontal craniotomy, identification of the fistula and closure of the meningeal opening with interrupted silk sutures or closure of it with sutures and covering of it with muscle, and (3) performance of unilateral transfrontal craniotomy, in which the dura is elevated, the opening is identified and a wick of iodoform gauze is placed between the lacerated dura and the cribriform plate, as Peet¹⁰ has advocated. The end of the gauze wick is brought out through the frontal incision, but the wick itself is left in place for four days and then carefully removed. Peet stated: "The object of this procedure is to prevent meningitis by allowing the brain to become firmly adherent to the lacerated dura thereby effectively closing off the subarachnoid space before organisms passing through from the nose can cause infection."

One of us (Adson) has used these accepted procedures with varied success; the one difficulty that has been encountered in attempting to free the dura from the cribriform plate is that the dura has had a tendency to tear, as Grant emphasized in his discussion of Coleman's paper. The dura, in addition to being thin, is likewise under moderate tension. This prevents the carrying out of proper overlapping of the dura, which is necessary for thorough invagination of the meningeal fistulous tract. We have included muscle in the suture line to assure against leakage of cerebrospinal fluid. This failure prompted one of us (Adson) to develop the operation employed in these cases of chronic rhinorrhea.

The procedure consists of performance of craniotomy which will allow the dura to be elevated from the bone in both halves of the frontal fossa. The bone flap must be designed so as to extend across the midline and to uncover the anterior poles of both frontal lobes (fig. 2 a). A coronal scalp flap incision is employed. It is placed within the hairline, after which the scalp and periosteum are reflected

10. Peet, M. M.: New York State J. Med. 28:555, 1928.

forward to a line just above the frontal sinus. Six trephine openings are made, the first two of which are placed on each side of the midline just above the frontal sinus. The second two trephine openings are placed on each side of the midline and the longitudinal sinus, approximately 3 cm. in front of the coronal suture. The third two openings are placed in the temporo-frontal region, one on each side. As the bone between all the openings is cut with a Gigli saw, an opening is effected which is sufficient to permit elevation of the dura and the frontal lobes. The bone flap is kept sterile during the operation by means of a

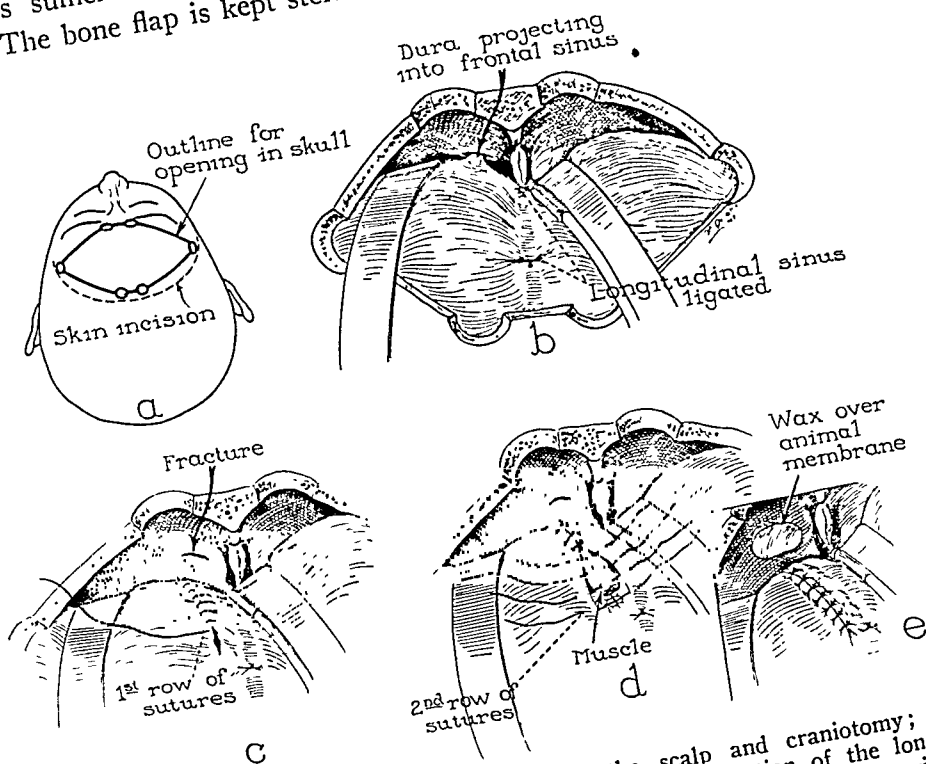


Fig. 2.—*a*, schematic outline of incision in the scalp and craniotomy; *b*, elevation of dura, identification of the fistulous tract and ligation of the longitudinal sinus; *c*, closure of the dural tear with a suture of continuous surgical gut; *d*, reinforcement of the primary closure by means of a second row of interrupted silk sutures, including a strip of muscle employed as additional protection against recurrence of the rhinorrhea; *e*, closure of bony opening with animal membrane and bone wax.

sponge soaked with isotonic sodium chloride solution. Caution is taken to avoid injury to the longitudinal sinus. Bleeding from the longitudinal sinus is controlled by ligation of the sinus (fig. 2 *b*) with silk ligatures at a level 6 cm. above the cecal foramen, which is situated superior to the crista galli. In some instances it is necessary to ligate the longitudinal sinus where it communicates with the cecal foramen. The advantage of ligation of the longitudinal sinus is that it allows the dura to be

sutured into and, if necessary, to be used in closure of, the fistulous tract. The procedure is continued by elevation of the dura from the frontal fossa and the olfactory grooves, where it is necessary to sacrifice the olfactory nerves. The elevation of the dura is continued until the anterior crest of the sella turcica is approached. During this dissection, the fistulous tract is always encountered, whether it be situated on the right or the left side. The meninges will be seen to extend into the defect of the frontal sinus or the cribriform plate.

After the dura has been mobilized sufficiently and the fistulous tract has been identified, plastic closure of the tract is begun by overlapping the dura in such a way as to invaginate the meningeal portion of the fistula. The first suture is placed in the most dependent part of the elevated dura (fig. 2 *c*). This suture is continuous chromic surgical gut no. 0. The primary line of suture is protected by a strip of muscle which is transfixed to the dura and further reenforced by the placing of a second row of interrupted silk sutures (fig. 2 *d*). The defect in the frontal sinus or cribriform plate is filled with Horsley's bone wax. To protect further against forcing of the wax through the cranial defect into the sinus or nose, Lukens' animal membrane is placed over the defect before the introduction of wax to plug the hole (fig. 2 *e*).

The advantages of bifrontal craniotomy are as follows: 1. A better exposure is obtained than by employment of a unifrontal flap. 2. The surgeon is always sure to identify the fistulous tract. 3. The exposure thus obtained affords a better opportunity for elevation of the meninges along the cribriform plate. 4. After elevation of the dura from the cribriform plate, tension on the dura is relieved; this permits greater ease of invagination of the fistulous tract and successful performance of overlapping dural closure of meningeal defects.

In addition to the cases that we have encountered in which spontaneous rhinorrhea developed because of large openings in the cribriform plate with the resulting protrusion of meninges forming a nasal meningocele which has not been recognized by the otolaryngologic surgeon, we also have observed a number of cases in which cerebrospinal rhinorrhea has developed as the result of the removal of a nasal polyp which in reality was a nasal meningocele (figs. 3 and 4). In 1 of our cases rhinorrhea developed after the removal of a large meningioma of the olfactory groove which had eroded the cribriform plate.

Another patient had been wounded with a .38 caliber revolver. The bullet entered the right temporal area, followed the wing of the sphenoid, perforated the cribriform plate and passed on through the left superior maxilla. The opening in the cribriform plate was larger than 1 cm. in diameter, with resulting profuse cerebrospinal rhinorrhea (fig. 5 *a*). This situation prompted one of us (Adson) to modify his previous

procedure by introducing a plate of tantalum. The usual bilateral trans-frontal craniotomy was employed. Loose fragments about the defect were removed. The tip of the crista galli was resected, after which the defect was covered with a layer of Horsley's bone wax. On top of this first layer of wax a layer of tantalum was cut and molded to bridge across the cribriform plate. The plate was intentionally perforated in order to encourage the wax to come through these openings to lock it in place and prevent it from slipping (fig. 5 *b* and *c*). A second

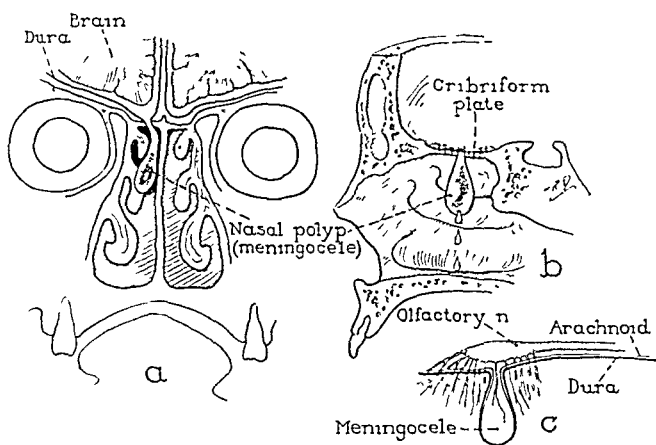


Fig. 3.—*a* and *b*, the course of a nasal meningocele; *c*, the relationship of the meningocele to the olfactory nerve.

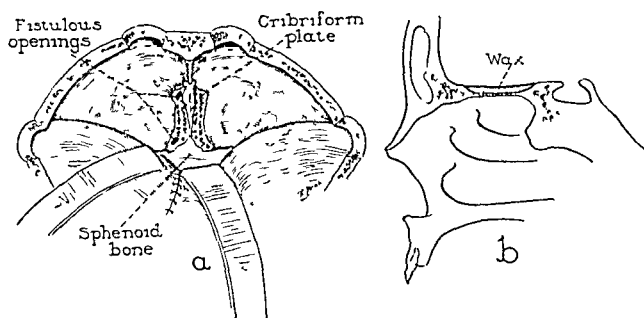


Fig. 4.—*a*, multiple fistulous openings in the cribriform plate; *b*, the use of Horsley's bone wax to obliterate the fistulous openings.

layer of wax was then placed over the top of the plate, molding it rather firmly into what had once been the olfactory grooves (fig. 5 *d*). In order to fix this plate further, it was heated by the use of the electro-coagulating current and needle. As the heat was applied, one could see the wax melt and subsequently mold into place.

Since the introduction of the tantalum plate along with the wax, which was first performed on Sept. 27, 1945, the method has been employed by Dr. Craig in 3 additional cases when he was dealing with

cribriform defects in the ethmoid bone. He has also used polythene as a covering for the fistulous opening in the meninges. Dr. Love and Dr. Baker on 2 occasions have used fibrin foam in place of Horsley's bone wax. Gelfoam® has also been used in addition to the wax for the purpose of hemostasis and for the stimulation of granulation about the

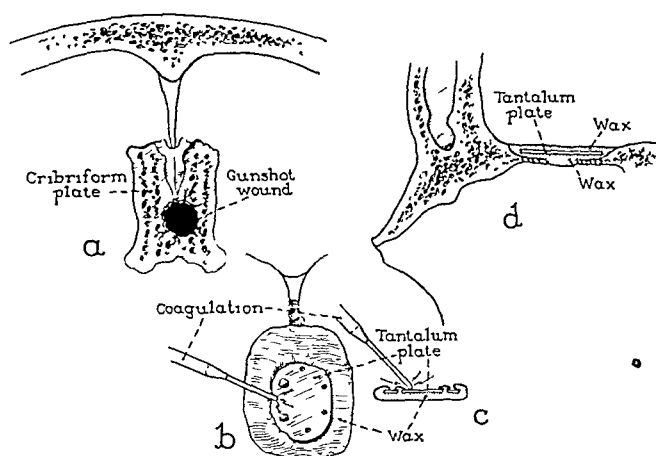


Fig. 5.—*a*, bullet wound in the cribriform plate; *b*, and *c*, insertion of the tantalum plate and the application of the electrocoagulating current in order to heat the plate and melt the wax to prevent slipping of the tantalum plate; *d*, relative positions of tantalum plate and bone wax.

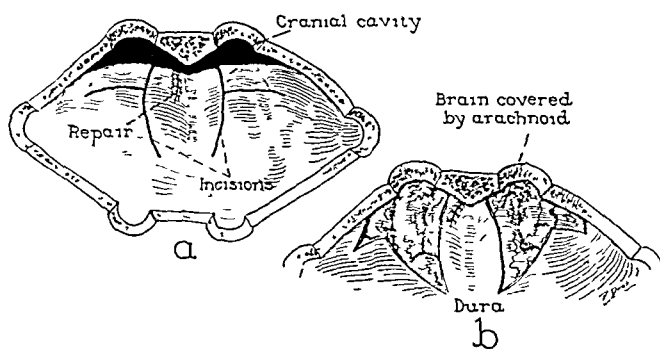


Fig. 6.—*a* and *b*, incisions in the dura employed in order to permit the arachnoid-covered frontal lobes to fill the anterior fossa.

fistulous opening. Since a space may remain between the dura and the anterior wall to the frontal bone when the dura is plicated to close the fistulous opening, one of us (Adson) has made elliptic incisions in the dura parallel and lateral to the longitudinal sinus and has added to them a lateral incision under each frontal lobe in order to allow the frontal lobes with arachnoid covering to expand forward and obliterate this space (fig. 6).

The accompanying table illustrates the incidence of cerebrospinal rhinorrhea in 26 cases and emphasizes that it occurs spontaneously twice

as frequently in females as it does in males and that in all cases the spontaneously developed rhinorrhea resulted from defects in the cribriform plate.

A REVIEW OF CASES IN WHICH OPERATION WAS PERFORMED

Traumatic cerebrospinal rhinorrhea occurred in 8 cases in which operation was performed. In 6 of these the rhinorrhea was the result of fractures extending through either the frontal or the ethmoid bone. In 1 case cerebrospinal rhinorrhea developed as the result of a large meningioma of the olfactory groove, and in 1 case it developed as the result of a bullet wound. Cerebrospinal rhinorrhea had been present for a varying number of years prior to operation. The longest period was twelve years, and the shortest period was five days. Meningitis had occurred in 6 patients, and in 3 patients remissions had also taken place. Three of these patients had undergone operation previously for rhinorrhea, unilateral craniotomy having been employed, with attempts at plastic closure of a fistulous opening. In 7 of the 8 cases operation

Cerebrospinal Rhinorrhea (26 Cases)

Origin	Sex		Sinuses		
	Males	Females	Frontal	Ethmoid	Frontal and Ethmoid
Traumatic.....	4	4	2	3	3
Spontaneous (nasal meningoceles).....	6	12	0	18	0
Total.....	10	16	2	21	3

was performed by one of us (Adson) and in the other case by Dr. G. S. Baker. The longest postoperative interval has been nine years. All 8 patients were cured. There were no deaths.

Spontaneous cerebrospinal rhinorrhea occurred in 18 cases in which operation was performed. Single fistulous openings were observed in 10 cases. Two or more fistulous openings were observed in 8 cases. Nasal polyps were observed by our otolaryngologists in 11 cases. Operation on nasal polyps (nasal meningoceles) had been performed at the Mayo Clinic or elsewhere in 9 cases. Our roentgenologists observed defects in the cribriform plate, with the presence of a mass in 3 cases. Dr. Hallberg, of the Section on Otolaryngology and Rhinology, permits me to quote him in stating the following:

I have seen 2 such patients. One was a 7 year old girl who had had a meningocele in the right side of her nose. The other patient was a man in his forties who had a meningocele in the left side of his nose. Both of these meningoceles had a whitish look and made their appearance in the nose between the septum and the middle turbinate. In this way they are differentiated from ordinary polyps, most of which originate in the middle meatus, that is, between

the middle turbinate and the lateral wall of the nose. If a meningocele in the nose is ruptured or torn, fluid can be seen trickling out of it by having the patient bend over. In most of the cases which we encounter cerebrospinal rhinorrhea comes on after intranasal surgical procedures, more often after removal of polyps than after any other type of operation. I do not feel that it is caused by trauma alone. I would not be surprised if, in some of them, meningoceles were mixed up in the polyp formation.

In further reviewing the 18 cases of spontaneous cerebrospinal rhinorrhea in which operation was performed, we learned that 12 of the patients were female and 6 were male. Two of the patients were children who had suffered from rhinorrhea from birth. In 1 case cerebrospinal fluid had continued to drain for fourteen years. In 3 cases fluid had drained for more than ten years. Remissions had occurred in 3 cases. Meningitis had occurred in 3 cases. In 2 patients previous attempts at repair had been made.

In addition, 3 patients who did not undergo surgical procedures have consulted us for cerebrospinal rhinorrhea. One patient was a woman, 48 years of age, who had suffered from cerebrospinal rhinorrhea for a period of nine years. She had had three attacks of meningitis, was admitted during her fourth attack and died two hours after admission. The second patient, a woman 40 years of age, gave a history of intermittent attacks of cerebrospinal rhinorrhea. After her examination had been completed, she was admitted to the hospital and was being prepared for surgical treatment with chemotherapy when the nasal drip ceased. Surgical intervention was postponed, and on recent examination we learned that she has not had a recurrence of her previous trouble with the exception of one morning when a few drops of clear fluid fell from her nose. This emphasizes the point that in an occasional case spontaneous recovery may take place. The patient made an interesting statement which was significant. She stated that prior to her initial admission to the clinic she had observed that the nasal drip was always greater when she was excited or had lost sleep. The third patient, a woman 40 years of age, complained of symptoms similar to those of which patients complain when cerebrospinal rhinorrhea is present. This patient was found to have what otolaryngologists like to refer to as an "allergic nose." No nasal polyps were demonstrable. One cubic centimeter of indigo carmine, which was introduced into the subarachnoid space by cisternal puncture, failed to appear in the nasal discharge; therefore, surgical intervention was not advised.

Surgical Results.—In 26 cases operation by the technic previously described by one of us (Adson) has been performed for cerebrospinal rhinorrhea. In 8 of these the rhinorrhea was of traumatic origin. All 8 patients were cured. In 18 cases cerebrospinal rhinorrhea developed spontaneously without a history of injury. Fourteen patients have been

cured. In 3 cases the operation was a failure. In 2 of the cases of failure reoperation has been performed without success. The results in the fourth case are equivocal since the patient has gone for many months without the appearance of cerebrospinal fluid in the nose and when it does appear only a few drops occur.

In regard to these failures, it is possible that the bone wax may have been dislodged as the result of sneezing or coughing which disturbed the sealed-off process effected at the time of surgical intervention. It is also possible that the wax had not been properly molded into the defect in the cribriform plate owing to the fact that soft tissue, the meninges, which extended through the cribriform plate, was not incised below the level of the bone. In 1 instance in which reoperation was performed it became apparent that there were several fistulous openings through the cribriform plate which had been overlooked at the primary operation.

SUMMARY

Cerebrospinal rhinorrhea due to trauma (fractures) frequently ceases spontaneously; therefore, it is wise to wait for a period of eight weeks before correcting the situation. Palliative measures are rarely effective. Only in an occasional case will the cerebrospinal fluid cease to drain after application of these measures.

Nasal polyps fairly frequently are nasal meningoceles. These may break and drain cerebrospinal fluid spontaneously but are sure to drain if resected; however, there is no doubt that a small meningocele may be associated with nasal polyps. Meningitis is a serious complication of cerebrospinal rhinorrhea, and this is especially true in the presence of acute infections of the nose, throat, tonsils and sinuses.

Administration of penicillin and the sulfonamide compounds reduces the hazard of meningitis and serves as a protective measure in the preoperative and postoperative periods.

Attempts at repair of fistulous openings through a unilateral frontal craniotomy have not been entirely satisfactory. This is especially true when the lesions are located in the cribriform plate, since they are frequently multiple and may occur on both sides of the septum.

The best results are obtained by bilateral frontal craniotomy, with adequate exposure of the cribriform plate before closure of the defects in the cribriform plate and the meningocele fistulous openings.

In 26 patients cerebrospinal rhinorrhea was relieved. Twenty-two patients were cured. There was 1 equivocal result, 3 failures and no deaths.

PSEUDOHEMOPHILIA OR CHRONIC THROMBASTHENIA

CHARLES W. McLAUGHLIN Jr., M.D.

OMAHA

THE CONDITIONS under discussion are those which have been called in the literature "pseudohemophilia or chronic hereditary thrombasthenia." These two dyscrasias were originally described nearly forty years ago, but it has only been in recent years that a clear differentiation has been drawn between the two entities and their characteristics more generally understood.

Glantzmann¹ in 1918 described a new diathesis occurring in both sexes characterized by bleeding of a purpuric type with hemorrhage from the mucous membranes and beneath the skin. In the original series the bleeding time, clotting time and platelet count were all reported to be normal. The clot retraction was delayed or absent. To this condition he gave the name "chronic hereditary hemorrhagic thrombasthenia" since he considered the platelets to be qualitatively defective. Subsequently cases considered to be in this group were reported by Van der Zande,² Rosenthal,³ Little and Ayres,⁴ Roskam⁵ and Minot.⁶ A careful review of the case reports, however, discloses that in a number of instances the findings in the blood originally described by Glantzmann were not present. In several of the patients whose condition was classified as "chronic hereditary thrombasthenia" the bleeding time was prolonged and clot retraction was found to be normal. Quick⁷ has observed that in the period since Glantzmann's

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1. Glantzmann, E.: *Hereditäre hämmorrhagische Thrombasthenie*, *Jahrb. f. Kinderh.* **88**:1, 1918.

2. Van der Zande, F.: *Pseudohemophilia*, *Nederl. tijdschr. v. geneesk.* **1**: 544, 1923.

3. Rosenthal, N.: *Hemorrhagic Diatheses—Chronic Hereditary Thrombasthenia*, in Downey, H.: *Handbook of Hematology*, New York, Paul B. Hoeber, Inc., 1938, vol. 1, p. 523.

4. Little, W. D., and Ayres, W. W.: *Hemorrhagic Disease: Familial Bleeding Tendency of Unusual Type with Splenomegaly Affecting and Transmitted by Both Males and Females*, *J. A. M. A.* **91**:1251 (Oct. 27) 1928.

5. Roskam, J.: *Purpuras hemorrhagiques et thrombopenia*, *Sang* **3**:497, 1929.

6. Minot, G. R.: *A Familial Hemorrhagic Condition Associated with Prolongation of the Bleeding Time*, *Am. J. M. Sc.* **175**:301, 1928.

7. Quick, A. J.: *The Hemorrhagic Diseases and Physiology of Hemostasis*, Springfield, Ill., Charles C Thomas, Publisher, 1942.

initial report there are few cases in the literature which correspond to his original description. He further concluded that it is difficult to accept the possibility that clot retraction can be defective when the platelet count, bleeding time and clotting time are all normal. While such a condition associated with abnormal bleeding due to faulty clot retraction may exist, it must be extremely rare, and the diagnosis should be made only when the specific requirements are met.

In 1926 von Willebrand⁸ described a family with a definite bleeding tendency in which the blood picture was characterized by a prolonged bleeding time with normal or slightly increased platelet count, a normal coagulation time, normal clot retraction and a negative reaction to the tourniquet test. This condition he called "pseudohemophilia." The original group were all found living on an island in the Baltic Sea where the disease was predominately observed in females, but subsequent studies have shown the sex incidence to be about equally divided. It was definitely proved, however, that the disease is transmitted by both sexes.

Estren, Midal and Dameshek⁹ have collected 62 cases from the literature since 1910 which they consider definite examples of pseudohemophilia. In each of these there was a history of excessive bleeding and a definitely increased bleeding time in the presence of a normal platelet count and usually a normal coagulation time. A definite family history of bleeding was obtainable in from 50 to 75 per cent of their series.

Pseudohemophilia usually develops in infancy but may be latent until adult life. In general, the bleeding diathesis tends to diminish in severity as the person grows older, although the bleeding time usually remains prolonged throughout life. The severity of the bleeding tendency in a given subject is difficult to estimate and may vary strikingly from time to time in the same person. Perkins¹⁰ has pointed out that the bleeding time in 1 of his cases fluctuated from eight minutes to an hour and twenty minutes in a few days' time by the same technic and varied during the same period in different sites of the body. Similar variations were observed in 1 of our cases.

Estren and others have recorded the common bleeding sites in their collected series as the nose in 75 per cent of the cases, the skin in 70 per cent and the gums in 25 per cent; the bleeding was of dental origin in 20 per cent. Bleeding from the gastrointestinal and urologic tracts and into the joints was much less frequently observed. Typical

8. von Willebrand, E. A.: *Hereditare pseudohemofili*, Finska läk.-sällsk. handl. **68**:87, 1926.

9. Estren, S.; Midal, L. S., and Dameshek, W.: *Pseudohemophilia*, Blood **1**: 504, 1946.

10. Perkins, W.: *Pseudohemophilia*, Blood **1**:497, 1946.

petechiae were distinctly unusual, but extensive subcutaneous hemorrhage with or without trauma and a tendency to bleed easily after minor injuries were commonly observed.

The conditions most frequently to be confused with pseudohemophilia are true hemophilia, thrombocytopenic purpura and chronic hereditary thrombasthenia (tables 1 and 2). Idiopathic hypoprothrombinemia may present almost identical clinical and laboratory findings except that the prothrombin time in this condition is persistently low and resistant to all therapy.¹¹

TABLE 1.—*Hemorrhagic Diseases—Differential Diagnosis*

	Pseudo-hemophilia	Hemophilia	Essential Purpura	Chronic Hereditary Thrombasthenia
Hereditary.....	Dominant	Recessive	.....	Dominant
Transmission.....	Male and female	Female	.....	Male and female
Bleeding tendency time after injury	Immediately	Usually delayed	Immediately	Immediately
Petechial.....	Uncommon	Absent	Common	Common
Ecchymotic.....	Common	Present	Extremely common	Common
Mucosal.....	Severe	Uncommon	Severe	Severe
Hemarthrosis.....	Uncommon	Common	Absent	Uncommon

TABLE 2.—*Blood Tests in the Differential Diagnosis of Hemorrhagic Diseases*

	Pseudo-hemophilia	Hemophilia	Essential Purpura	Chronic Hereditary Thrombasthenia
Bleeding time.....	Prolonged	Normal	Prolonged	Usually normal
Coagulation time.....	Normal	Prolonged	Normal	Normal
Platelet count.....	Often increased	Normal	Decreased	Normal or low
Tourniquet test.....	Positive or negative	Negative	Positive	Usually positive
Clot retraction.....	Usually normal	Normal	Absent	Prolonged

The underlying pathologic process in pseudohemophilia is as yet not clearly understood but probably lies in the vessels themselves. MacFarlane¹² has shown by microscopic studies of the nail beds of patients with this condition that there exists distorted and bizarre patterns with little or no response to injury. Subsequently Perkins repeated MacFarlane's work and was able to confirm the presence of abnormal capillaries which did not respond to ordinary stimuli. Dameshek¹³

11. Rhoads, J. E., and Fitz-Hugh, T., Jr.: Idiopathic Hypoprothrombinemia—An Apparently Unrecorded Condition, *Am. J. M. Sc.* **202**:662, 1941.

12. MacFarlane, R. G.: Critical Review: Mechanism of Hemostasis, *Quart. J. Med.* **10**:1, 1941.

13. Dameshek, W.: Medical Progress—Hemorrhagic Diseases, *New England J. Med.* **230**:542, 1944.

attempted to repeat MacFarlane's studies, without definite success. He concluded that the abnormal mechanism in this condition must as yet be considered unknown.

That the platelets are normal in true pseudohemophilia apparently has been adequately demonstrated. Buckman¹⁴ has shown that blood from a patient with pseudohemophilia added to blood from a hemophilic patient causes rapid coagulation, as will blood from a normal donor.

There is no satisfactory or specific therapy for pseudohemophilia to date. Calcium and vitamin C have been used without benefit to the bleeding tendency. Vitamin K is without benefit since prothrombin levels are normal in cases of proved pseudohemophilia. Irradiation over the spleen has been tried, with little success. Splenectomy has been attempted in 4 patients, 1 of whom succumbed four hours after operation with uncontrollable hemorrhage. Two other patients evidenced no clinical improvement, and the fourth patient, while showing slight general benefit, retained the same bleeding tendency. Snake venom has been suggested as a therapeutic agent since it acts as thrombo-kinase converting prothrombin into thrombin in the presence of calcium. Venom was given a prolonged trial in 1 of our cases, with little evident effect. Transfusions of whole blood have a variable influence on active hemorrhage in pseudohemophilia. While in some instances they seem to allay the tendency to bleed for a time, the major benefit is apparently through replacement of blood lost.

It is well established from ample experience that elective surgical intervention in these patients is to be undertaken only after serious consideration. Hemorrhage may be most difficult to control or fatal in certain instances. Death from persistent bleeding following minor injuries, however, is rare, only 2 cases being found in the literature in the past thirty years. It may, therefore, be concluded that the prognosis for life is excellent, and although the bleeding tendency persists, it may become less marked as the patient grows older. It is extremely important to recognize the tendency from the standpoint of prophylaxis.

We have recently had occasion to observe 2 children who demonstrated the characteristic findings which have been classified under the name of "pseudohemophilia." The 2 cases are here reported.

CASE 1.—D. K., a white male child 18 months of age, was admitted to the hospital on June 19, 1946, five days after sustaining a dog bite of the face. The family history did not reveal any instances of a bleeding diathesis. The patient, however, had been observed to bleed easily from minor trauma since birth. The child had been attacked by a dog five days before admission, sustaining a deep

14. Buckman, T. E.: Atypical Pathologic Hemorrhage in Early Life, *Am. J. M. Sc.* **175**:307, 1928.

fang bite centrally placed in the right cheek. Initial bleeding was profuse, and after local cleansing primary suture was done by the family physician. The wound continued to ooze, and the child was referred to the hospital for further care.

On admission the child was seen to be well nourished but pale and apprehensive. There was a 1 cm. wound centrally placed in the right cheek closed by three deep sutures. There was a large blood clot loosely adherent to the suture line, with fresh oozing from beneath the clot. There was no penetration of the wound into the mouth. The liver and spleen were not palpable, and the regional nodes were not enlarged. There were several areas of subcutaneous hemorrhage noted over the extremities. The reaction to the tourniquet test was negative.

Initial laboratory studies showed nothing striking except the evidence of considerable loss of blood. The hemoglobin content was 6.6 Gm., the red blood cell count was 2,270,000 and the white blood cell count was 6,000. A differential count showed 13 per cent segmented cells, 2 per cent staff cells, 74 per cent lymphocytes, 5 per cent monocytes and 6 per cent eosinophils. The bleeding time was seven minutes, the clotting time was seven minutes and the platelets numbered 232,000.

On the day of admission 250 cc. of citrated blood was given after exposure of the left long saphenous vein. It was noted that this small wound did not bleed abnormally. The following day the wound on the face was still oozing, and on the third day after admission it was explored under open drop ether anesthesia. The original sutures and the old blood clot were removed. The wound was seen to be 1 cm. long and 1 cm. deep and was not grossly infected. One vein in the soft tissues seemed to be the source of bleeding. This was ligated, and the wound was closed with three deeply placed sutures with hemostatic gauze tied over the line of closure.

The wound continued to bleed intermittently during the next two days, and it was again explored under general anesthesia three days later. A piece of necrotic tissue was removed, but no specific bleeding points could be identified for ligation. Three pieces of gelfoam® were buried in the wound and dead space obliterated by fine surgical gut suture. The skin was closed with silk and a collodion dressing applied.

After this procedure there was little further bleeding, and the child was dismissed on the eleventh day in the hospital with the wound healing satisfactorily.

On Sept. 7, 1946, approximately two months later, the child was readmitted to the hospital. A week before admission he had been bitten by a mosquito on the shoulder, and the area was scratched, with resultant persistent bleeding which had continued. In the interval since discharge the face had become completely healed, with minimum scarring, but areas of spontaneous subcutaneous hemorrhage had been frequently noted.

On this admission there were numerous small areas of subcutaneous hemorrhage visible over the trunk. The left leg was markedly swollen from the knee to the ankle because of massive hemorrhage into this extremity, which had developed spontaneously three days before admission. Laboratory data showed the hemoglobin content 7.9 Gm., red blood cell count 3,850,000, white blood cell count 16,500, with 60 per cent segmented cells, 8 per cent staff cells, 28 per cent lymphocytes and 4 per cent monocytes. The ear was stuck for a blood specimen and continued to bleed for twenty-four hours. The bleeding time continued to be somewhere between one and twenty-four hours. The clotting time by the test tube method was ten minutes. The clot retracted, but this was slightly delayed. The platelets numbered 200,000. The child was given 250 cc. of citrated blood through an exposed saphenous vein, again there being no abnormal bleeding from this small surgical incision.

Bleeding from the mosquito bite ceased after the transfusion and did not recur during the twenty day stay in the hospital. The areas of subcutaneous hemorrhage faded, and the massive hemorrhage into the left leg gradually absorbed, with no involvement of the joints. The spleen progressively enlarged during observation in the hospital until it was palpable 3 fingerbreadths below the left costal margin. It then receded and was not palpable at the time of dismissal. The child was dismissed on snake venom, 0.2 cc. to be administered twice weekly.

In June 1948, two years after the first admission, he was again admitted for further study. During this period he had grown and developed normally. However, he had frequently evidenced large areas of subcutaneous hemorrhage without known trauma and had also had massive hemorrhages into the legs and thighs and over the scapulas. These had always resolved without residual defect. There had never been any gastrointestinal bleeding, and the spleen had never again been palpable.

On this admission, many areas of subcutaneous hemorrhage were noted over the buttocks and over both lower extremities. The reaction to the tourniquet test was again negative.

TABLE 3.—*Laboratory Data on Baby D. K., Aged 18 Months**

	June 19, 1946 †	June 22, 1946 †	Sept. 7, 1946 †	Sept. 27, 1946	June 2, 1948
Hemoglobin, Gm.....	6.6	8.9	7.9	9.4	13
Red blood cells.....	3,270,000	3,410,000	3,850,000	3,100,000	4,950,000
White blood cells.....	6,000	7,500	16,500	8,600	5,400
Differential count.....	Normal	Normal	Normal	Normal	Normal
Bleeding time.....	7 min.	6 min.	30 + min.	1 to 36 hr.	18 + min.
Coagulation time, min.....	5	10	10	10	12
*Platelets	232,000	.....	.....	200,000	90,000 to 120,000

* The prothrombin time, clot retraction and bone marrow were normal.

† Transfusion of blood given.

‡ Sutures applied.

An examination of bone marrow was carried out by needle puncture on June 2, 1948. The bone marrow was reported to be moderately hyperplastic, with megakaryocytes present. It is noteworthy that the sternal puncture wound bled for seventy-two hours and a needle puncture wound in the heel at the same time for a blood specimen bled for twenty-four hours. The hemoglobin content was 13 Gm., the red blood cell count 4,950,000 and the white blood cell count 5,400, the segmented forms numbering 56, staff forms 8, lymphocytes 46, monocytes 2 and eosinophils 2. The clotting time was twelve to eighteen minutes. The clot retraction began in thirty minutes and was complete in five hours. The platelets were reported to number 130,000 and on succeeding days 90,000, 82,000 and 84,000. This decrease was noted only at the time of this admission to the hospital, all previous counts being between 175,000 and 250,000. The child had been given snake venom during the two year period, and the use of this was discontinued at the time of the third admission. The hemorrhagic tendency still persists, but general development has been normal to date (table 3).

The final diagnosis was pseudohemophilia. Essential thrombocytopenic purpura was seriously considered for a time, particularly when the platelets were definitely reduced in number. However, the striking splenomegaly observed for a few days in this child is practically never seen in essential purpura.

CASE 2.—K. H., a white male infant 1 year of age, was admitted to the hospital on Aug. 4, 1947, with persistent bleeding from a small wound in the tongue. Two days before admission the child fell at play, biting the lateral edge of the tongue. The area bled profusely and was controlled intermittently by pressure during the first twenty-four hours. Subsequently it began to bleed continuously, and the child was referred to the hospital for further study.

Physical examination on admission disclosed a rather fat child of 1 year who was pale and had obviously lost considerable blood. Inspection of the oral cavity demonstrated the presence of fresh blood, with a large blood clot over the left lateral edge of the tongue. Removal of the clot disclosed a small deep puncture wound 3 mm. in length which did not go completely through the tongue. The spleen was not palpable, and there were no enlarged lymph nodes. Numerous areas of subcutaneous hemorrhage varying in size were visible over the trunk and extremities.

The only instance of a bleeding diathesis in the family involved an older brother. Four years before a male baby 6 months of age in the same family sustained a small puncture wound of the tongue. Bleeding was profuse and persisted, and the child died from loss of blood in a hospital while arrangements for a transfusion were being made. No blood studies were available.

The initial laboratory studies showed a hemoglobin content of 56 per cent, a red blood cell count of 3,500,000 and a white blood cell count of 12,000. The differential count was normal. The bleeding time was reported to be thirty minutes, the clotting time twelve minutes and the platelets 250,000.

The following day oozing had persisted, and under general anesthesia the wound in the tongue was carefully inspected and closed with two deeply placed silk sutures tied over a piece of gelfoam.[®] A transfusion of 125 cc. of blood was given. The wound had remained dry the following day, and the bleeding time was found to be twenty minutes and the clotting time five minutes. The child was dismissed under the further care of the referring physician.

On August 9, three days after dismissal, the child was readmitted with further bleeding from the tongue. This was apparently induced by chewing on a plastic toy when his arms were temporarily freed from the prescribed restraints. The bleeding persisted, and the following day the child was given 150 cc. of blood and the tongue again inspected under divinyl oxide anesthesia. Three silk sutures were introduced deep to the puncture wound and tied over a piece of gelfoam.[®]

Bleeding was entirely controlled for three days but recurred again on August 13, when a third transfusion of 175 cc. of blood was administered. The tongue was again exposed under general anesthesia, and while the original wound appeared almost healed, persistent oozing was noted from the silk suture holes. These were closed with deeply placed sutures over gelfoam.[®] It was of interest that no abnormal bleeding occurred from the small cut-down incision used to expose the long saphenous vein for transfusion.

An examination of bone marrow was made on August 13 and was reported as follows: Cytologic examination of marrow elements reveals a normal distribution of the myeloid-erythroid series. Various stages of maturation of red cells are present, varying from the occasional megaloblast to the mature red cells. No abnormal number of myeloblasts are present. The megakaryocytes appear normal in number and show normal pseudopodia in which platelets are present. Abnormal forms such as sharply defined cytoplasmic borders with a loss of granularity of the cytoplasm and vacuolization of the cytoplasm are present. The diagnosis is normal bone marrow.

Three days later, on August 16, the bleeding recurred in a profuse form. A fourth transfusion of 150 cc. of blood was given and the bleeding site again closed with mattress sutures tied over gelfoam® impregnated in topical thrombin.

On August 17, only eighteen hours after the fourth attempt at local control of bleeding by suture, the wound was again observed to be oozing briskly. A transfusion (the fifth) of 150 cc. of blood was given, and after considerable discussion the left external carotid artery was exposed in the neck under general anesthesia. The external carotid artery was doubly ligated with silk sutures just above the superior thyroid branch, and this vessel was ligated in addition as a precaution. No excessive bleeding occurred from this incision in the neck. The previously placed sutures in the tongue were removed, and no further oozing was observed.

On August 21, four days after the carotid ligation, there was only a little oozing noted from the tongue. The incision in the neck appeared normal. Two days later, sudden profuse hemorrhage from the tongue again occurred and persisted for two hours. The child was given a sixth transfusion of 150 cc. of blood, but further local suture was not immediately undertaken.

Bleeding stopped spontaneously and did not recur for five days, when there was again profuse sudden hemorrhage from the tongue. The child was given a seventh

TABLE 4.—Laboratory Data on Baby K. H., Aged 1 Year *

	Aug. 4, 1947 ††	Aug. 11, 1947 ††	Aug. 14, 1947 ††	Aug. 25, 1947 †§	Aug. 28, 1947 †‡	May 18, 1948
Hemoglobin, per cent.....	53	81	71	35	45	60
Red blood cells.....	3,480,000	3,940,000	4,010,000	2,350,000	2,470,000	2,980,000
White blood cells.....	12,000	11,600	11,700	.....	8,950	8,000
Differential count.....	Normal	Normal	Normal	.....	Normal	Normal
Bleeding time, min.....	30	20	.....	.....	.....	6½
Coagulation time, min....	5	3.5	.....	.....	.....	2
Platelets	294,000	.....	.....	.....	.....	342,000

* The prothrombin time, clot retraction and bone marrow were normal.

† Transfusion of blood given.

‡ Sutures applied.

§ Carotid ligation.

transfusion of 240 cc. of blood and the tongue exposed under divinyl oxide anesthesia. The original wound on the lateral dorsum appeared dry and practically healed. There were two puncture wounds on the lateral edge of the tongue with raised edges appearing much like old suture wounds, and from these brisk bleeding was noted. The holes were carefully explored, and no foreign material was found. The tongue felt entirely normal to palpation. The puncture wounds were closed with 000 chromic surgical gut sutures, with prompt control of the bleeding. There was no further hemorrhage, and the child was dismissed from the hospital on August 30 with the wound dry.

He was readmitted nine months later, on May 17, 1948. For one week prior to admission there had been persistent bleeding from the gingival mucosa over an erupting upper right molar tooth. On this admission numerous areas of subcutaneous hemorrhage were again noted, but the spleen and regional nodes were not palpable. During the preceding months the child had bled freely on a number of occasions after minor cuts and scratches, but in every instance this had stopped spontaneously. On this admission the bleeding time was six and a half minutes, and the coagulation time two minutes by the capillary tube method, and clot retraction began in one hour and was complete in three hours, with a firm clot. The prothrombin time was 16.5 seconds, or 105 per cent of normal. The hemoglobin

content was 7.5 Gm., the red blood cell count 2,980,000 and the white blood cell count 8,000. The differential count was normal. The platelets numbered 342,000.

Three days after admission the child was given 180 cc. of blood because of persistent oozing, after which the bleeding ceased. A sample of the baby's venous blood was mixed with his saliva and the coagulation time checked against a control specimen from the patient, without significant difference in the result.

At the time of dismissal the gums were no longer bleeding and the hemoglobin content was 9.5 Gm., with a red blood cell count of 3,010,000 (table 4).

The diagnosis was pseudohemophilia. While the bleeding time was not so strikingly prolonged in this case, it was increased at times, and all other laboratory data were in keeping with this diagnosis.

The family history was of unusual interest in that an older brother died with a similar history. While data are inadequate to make a diagnosis, they are certainly suggestive and noteworthy since only two previously reported cases of fatal hemorrhage have been found in the literature.

SUMMARY AND CONCLUSIONS

1. Pseudohemophilia and chronic hereditary thrombasthenia are probably two distinct entities.
2. Both conditions present themselves as hemorrhagic diathesis, usually familial in type but not sex linked.
3. Pseudohemophilia is a more clearly established condition in which the principal diagnostic feature is a persistently prolonged bleeding time.
4. Two cases classified as instances of pseudohemophilia are reported.
5. There is no specific therapy for pseudohemophilia, but the various means of controlling hemorrhage have been discussed.
6. Pseudohemophilia is rarely fatal, the bleeding tendency usually becoming less marked with advancing years. Surgical treatment should be avoided unless absolutely required.

DISCUSSION

DR. GEORGE CURTIS, Columbus, Ohio: V. P., a baby boy of 10 months, was admitted to the University Hospital on Jan. 6, 1944, presenting the clinical problem of "a bleeding tendency." He had had recurrent crops of subcutaneous ecchymoses, beginning at the age of 7 months and continuing up to the time of admission. There were no other obvious signs or symptoms in this well developed, well nourished and otherwise apparently normal infant. No other bleeding had been noted, and there was no familial history of any hemorrhagic diathesis, including hemophilia. The patient had 2 brothers and 1 sister, who were normal, as were the parents.

On admission, the patient presented red cheeks and mucosae and only one ecchymotic area, about 1 cm. in diameter, on the left knee. The general physical examination was essentially noncontributory. There was no lymphadenopathy. The liver and spleen were not palpable. The temperature was normal. The baby's disposition was excellent, and the diet was well taken. There was no blood in the urine.

The blood count on admission was: white blood cells, 23,300; red blood cells, 5,190,000; hemoglobin content, 9 Gm.; blood platelets 290,000 per cubic millimeter, and cell volume, 41 per cent. The sedimentation rate was normal. The bleeding time was three minutes. The coagulation time (Howells' method) was twenty-two minutes. Clot retraction was normal.

The following day, January 7, the white blood cells numbered 13,450, with 28 per cent granulocytes, 66 per cent lymphocytes and 6 per cent monocytes. The red blood cell count was 4,370,000, with 1.4 per cent reticulocytes, 9 Gm. of hemoglobin and over 1,000,000 platelets per cubic millimeter.

Forty-eight hours after admission (the morning of January 8) we were greatly disturbed to find the little fellow pale, inactive and unresponsive. The red blood cell count had fallen to 1,830,000, the hemoglobin to 5.5 Gm. and the platelets to 231,000. The white blood cell count was 22,200, with 84 per cent polymorphonuclear cells, 15 per cent lymphocytes and 1 per cent monocytes. During the succeeding seven hours the red cells fell to 1,190,000 and the hemoglobin to 4 Gm.; the baby appeared moribund. There was no frank icterus. Neither the spleen nor the liver was palpable. There was no evidence of external loss of blood. There was evidence of extensive hematoma formation in the left leg, however, not apparently sufficient to cause such a precipitous fall of the red cells.

Studies of erythrocyte fragility at this time were suggestive. One hundred cubic centimeters of blood was immediately started into the marrow of the left tibia. The red blood cell count rose to 1,900,000. This was followed by a second transfusion, after which the count rose to 3,060,000 and the hemoglobin content to 7.8 Gm. The prothrombin time was 107 per cent. There was no evidence of external hemorrhage, although hematoma formation in the left thigh was obvious. There was no significant thrombocytopenia at this or any other time.

Subsequent studies of both serum and cells indicated an inherent increased fragility of the red cells, regarded as suggestive of hemolytic icterus of the congenital type.

Sternal aspiration revealed a grossly hyperplastic bone marrow, with the myelocytes normal, as well as a definite hyperplasia of the erythrocyte cells, most of which were in the normoblastic stage. There were many megakaryocytes including many young mononucleated forms such as characterize the splenic type of thrombocytopenic purpura.

Eleven days after admission (January 17) it was possible to palpate an enlarged spleen for the first time,

Thus, accumulating evidence appeared to point toward a syndrome consisting of splenic hemolysis together with a secondary intermittent thrombocytolysis, and the factor of hypersplenism came under consideration. As a consequence splenectomy was considered and then advised, in the double hope of preventing a recurrence of any erythroclastic activity and the purpuric manifestations. After another preoperative blood transfusion a 27 Gm. spleen, measuring 6.5 by 2 by 3.2 cm., was removed on January 20 without any difficulty and with no immediate complication. Fortunately, the surgical anatomy was such that only three intra-abdominal ligatures were necessary, one on the ligament to the diaphragm, along the cardia, one on the pedicle and one on the pedicle of an accessory spleen removed from along the greater curvature of the stomach.

During the procedure the peritoneum did not become freckled with purpuric spots, as it ordinarily does during splenectomy for thrombopenic purpura. The wound, however, was soggy, and the oozing continued even after the splenectomy, during closure.

Supravital staining of scrapings of the splenic pulp revealed a great increase in highly phagocytic clasmatocytes, as well as numerous sequestered blood platelets. Lymphopoiesis was normal, as was other cellular activity. The microscopic sections revealed hyperplasia of the reticulum cells.

Later in the day it was noted that the dressings were stained with fresh blood. On closer inspection, two points of oozing were discovered in the incision. This was superficial. At no time was there any evidence of internal hemorrhage.

The total red blood cell count rose from 3,500,000 preoperatively to 5,000,000 postoperatively and the hemoglobin from 8.8 to 12.5 Gm. The spleen had been well massaged just previous to the splenectomy. The blood platelets rose to 1,355,000 immediately after operation. Later during the same day the platelets fell to 134,000 per cubic millimeter and the red blood cells to 2,810,000. The white blood cell count was 25,000, with 77 per cent granulocytes.

The steady oozing continued. Consequently, various methods were used to control the bleeding from the site of the incision, including repeated small blood transfusions. The wound was opened and resutured; however, there was no single vessel to ligate. Pressure was helpful, but bleeding resumed when it was released. Adhesive strapping was helpful. Gelfoam® was not available. Epinephrine in 1 to 1,000 dilution, applied locally, would stop the ooze for a while. The best result was obtained by the use of thrombin topically. The hemoglobin and red cells did not return to a critically low level even in these trying circumstances. Yet intermittent bleeding continued for three weeks, even though the capillary coagulation time, read from the blood as it collected in the oozing suture line, was normal. Infection of the wound did not occur. Sulfadiazine was used locally as well as generally.

While the prothrombin time and blood platelets fluctuated considerably, at no time were they sufficiently low to account for the bleeding, which occurred not only in the operative incision but also at times at the site of diagnostic needle puncture in the finger or lobe of the ear.

It is our present feeling that there exists, in addition to the known factors essential to blood coagulation, some other important element which was lacking in this little patient and that this deficiency probably persisted, even after splenectomy. This can be proved by the test of time together with further experience and investigation. In the meantime every precaution should be taken with this patient to prevent any unnecessary trauma which might result in restarting a hemorrhage so difficult to control. It is possible by repeated transfusions of fresh whole blood to control the boy's hemorrhagic tendency. If facilities are available for this lifesaving measure, there should be no great immediate danger.

On discharge (Feb. 13, 1944) the white blood cell count was 26,000, the red blood cell count 3,540,000, the reticulocytes 4.4 per cent, the blood platelets 969,000 and the hemoglobin 9.3 Gm. Removal of the enlarged spleen should prevent any further tendency toward splenic hemolysis and the splenic destruction of platelets such as occurs in thrombopenic purpura. Generous amounts of vitamin C and vitamin K appear to be indicated, to insure against any deficiencies of these factors in the blood coagulation mechanism.

Splenectomy is contraindicated for the enlarged spleen occurring in the course of pseudohemophilia.

DR. CHARLES W. McLAUGHLIN JR., Omaha: One point which I should like to stress is that the bleeding time, which is the one essential in making an accurate diagnosis, varies strikingly in these patients. In Dr. Curtis' case it was three minutes at the time the patient had intractable bleeding after splenectomy. One must make repeated determinations of the bleeding time from different sites before a final diagnosis is made.

SURGICAL TREATMENT OF BENIGN AND SECONDARILY MALIGNANT TUMORS OF THE ESOPHAGUS

STUART W. HARRINGTON, M.D.
ROCHESTER, MINN.

THE OCCURRENCE of benign tumors of the esophagus has been known since an early period of clinical diagnosis of lesions of the esophagus. The growths which were diagnosed at that time were of the pedunculated polypoid type and were recognized because of the periodic appearance of the tumor or its extrusion into the mouth of the patient. The treatment of these growths is probably the earliest of recorded surgical procedures for tumors of the esophagus.

Sussius (Susio) is credited by Minski¹ with one of the earliest necropsy descriptions (1559) of an esophageal polyp, which extended from the middle part of the esophagus to the cardia of the stomach, causing obstruction and death. Minski also credited to Dallas and Monroe one of the earliest attempts at surgical removal, which was carried out by them in 1763 on a 64 year old patient who, on vomiting, forced multiple pedunculated tumors into the mouth, causing severe laryngeal obstruction. Transoral removal of the growths was decided on, and a preliminary tracheotomy was done to prevent suffocation during the procedure. A portion of the pedunculated tumors was ligated with a snare and permitted to drop into the esophagus. The patient died two years later (April 1765) from starvation, the result of esophageal obstruction from continued growth of the remaining tumors.

Although the occurrence of benign tumors has been known for many years, they are relatively infrequent. Their subjective symptoms and clinical manifestations are often meager, a fact which often delays their clinical recognition. The only effective treatment for these growths is complete surgical removal, which often requires extensive operative procedures. Their surgical treatment has developed slowly because of the many problems involved. These problems are concerned not only with the establishment of a definite diagnosis but also with complex technical considerations of operative treatment.

From the Division of Surgery, Mayo Clinic.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 3, 1948.

1. Minski, P. R.: Zur Entwicklungsgeschichte und Klinik der Polypen und polypenähnlichen Gewächse des Rachens und der Speiseröhre, Deutsche Ztschr. f. Chir. 41:513-587, 1895.

The development of roentgenologic and endoscopic methods of examination of the esophagus has made it possible to make an early diagnosis of the presence of a lesion and also to determine the location, extent and character of the lesion. The accurate information obtained from these methods of examination has been an important factor in the development of methods of treatment and is essential to the determination of the type of surgical treatment to be instituted.

The study of proved cases has shown that these tumors occur in different locations of the esophagus. The histologic examination of the growths shows that they arise from different tissues of the wall of the esophagus and that they may undergo malignant change.

In May 1944 I reported, before the American Association for Thoracic Surgery, 5 cases in which I had treated benign tumors of the esophagus surgically.² The purpose of the present paper is to report 6 additional cases in which I have operated since that time and to give a statistical statement of the clinical manifestations, surgical treatment and histologic observations in the entire series.

These benign tumors are of two general groups, the mucosal and the extramucosal or intramural tumors. The mucosal tumors are usually pedunculated and arise from the submucosa. They are of two types: lipofibromas, which have a single pedicle, and fibromyxomas, which may be multiple and have multiple pedicles. The extramucosal or intramural tumors arise from the muscle of the wall of the esophagus. They are usually of multicentric origin and present as multiple leiomyomas involving a considerable part of the wall of the esophagus or as leiomyomatosis involving the entire circumference of the esophageal wall, but occasionally there is a single circumscribed tumor. When the tumors are benign they do not involve the mucous membrane, but they may undergo malignant change and invade the mucosa, causing ulceration and hemorrhage.

The growth of benign tumors of the esophagus is usually slow, and they may attain considerable size without giving rise to subjective symptoms. This is particularly true of the intramural tumors, which rarely produce obstruction of the esophagus unless they attain great size. The common symptoms associated with these growths are dysphagia, substernal pain, regurgitation of food, cough and dyspnea. The pedunculated tumors are commonly associated with obstructive symptoms, and the diagnosis is often definitely established by regurgitation of the tumor into the mouth, which may be the first objective sign. Regurgi-

2. Harrington, S. W., and Moersch, H. J.: Surgical Treatment and Clinical Manifestations of Benign Tumors of Esophagus with Report of Seven Cases, *J. Thoracic Surg.* **13**:394-414 (Oct.) 1944.

tation of these growths into the nasopharynx can imperil life because of blocking of the trachea, which may result in strangulation.

The roentgenographic and roentgenoscopic examination of the esophagus is of great value in determining the presence of the growths. Esophagoscopy is of utmost importance in establishing a definite diagnosis, although at times it may be difficult to determine the site of origin as well as the type of growth because of the difficulty in obtaining a specimen for biopsy through the normal esophageal mucosa. The site of origin of the pedunculated tumors usually can be determined definitely.

The indications for surgical treatment of benign tumors are not as urgent or as imperative as for malignant lesions of the esophagus. They depend somewhat on the patient's general condition, the amount of difficulty the tumor is causing and the site of the tumor. Inasmuch as the growths may undergo malignant change, surgical treatment should be considered in all cases.

The surgical treatment of these tumors depends on whether the growth is submucous or pedunculated or is intramural and arises from the muscular coat of the esophagus. The pedunculated tumors may be more accessible and amenable to surgical treatment than the intramural tumors. If the pedunculated tumor is small and its origin is high at the introitus, it may be removed through the mouth with a snare and cautery. Larger tumors of this type require cervical esophagotomy. The tumors may attain such huge size as to require transthoracic esophagotomy. This approach also may be necessary if the pedicle of the tumor is situated low in the esophagus.

The indications for surgical treatment of intramural tumors are not as a rule as urgent as those for pedunculated tumors, because the former usually do not cause obstructive symptoms. The surgical treatment of these tumors often requires a much more extensive operative procedure than is necessary in cases of pedunculated tumors. The type of operative procedure to be carried out for intramural growths cannot be definitely determined by the clinical examinations, because of the difficulty in determining the type or extent of the growth. The accurate determination of the factors on which the indications for the type of operative procedure depend can be definitely made only at the time of operation. If the intramural tumors involve only a segment of the wall of the esophagus they may be removed by transthoracic and transpleural local excision of the tumor from the wall, which is then reconstructed. If the growth involves the entire esophageal wall, its removal will require transthoracic and transpleural resection of the esophagus and transdiaphragmatic esophagogastric anastomosis.

REPORT OF CASES

The following is a summary of 6 cases in which I have operated since 1944; in 4 of these cases the tumors were benign intramural leiomyomas, and in the remaining 2 they were malignant leiomyosarcomas. In the subsequent section of the paper I shall include the 5 cases which I have previously reported, in 2 of which the tumors were pedunculated submucosal tumors and in 3 intramural leiomyomas. These 5 cases were reported before the American Association for Thoracic Surgery in May 1944.

CASE 1.—A man, aged 31 years, came to the Mayo Clinic because of the finding of a "tumor in the chest" by a routine roentgenologic examination of the thorax. He had had no subjective symptoms prior to the roentgenologic examination.

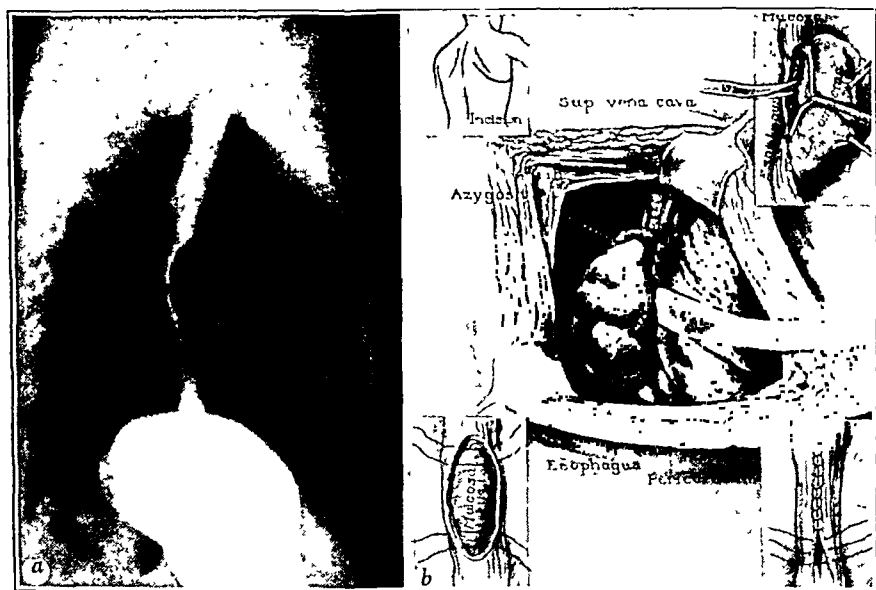


Fig. 1.—Intramural leiomyoma of middle third of the esophagus. Transpleural esophagotomy on the right side, with complete removal of tumor and reconstruction of the wall of the esophagus. *a*, rounded tumor of the right wall of the middle third of the esophagus partially obstructing its lumen on the patient's admission to the hospital; *b*, technic of complete excision of the tumor without opening the mucous membrane and complete reconstruction of the wall of the esophagus.

Three months prior to his admission to the clinic, after the tumor had been found, he had a nonproductive cough and a vague painful sensation in the anterior portion of the thorax.

The results of physical examination were negative. The roentgenogram of the thorax and esophagus revealed a rounded tumor mass displacing the esophagus to the right and posteriorly at the level of the carina (fig. 1 *a*). Because of the roentgenologic findings, an esophagoscopy examination was carried out, and a tumor was found involving the anterior and right lateral wall of the middle third of the esophagus. It appeared to be intramural.

A diagnosis was made of leiomyoma involving the anterior and right lateral wall of the middle third of the esophagus, and surgical intervention was advised.

Accordingly on July 8, 1944, transpleural esophagotomy, with complete resection of the tumor and reconstruction of the wall of the esophagus, was performed on the right side. The pleural cavity was entered by incision of the pleura through the posterior periosteum of the sixth rib, exposing a large tumor involving the wall in the middle third of the esophagus, just beneath the azygos vein (fig. 1 *b*).

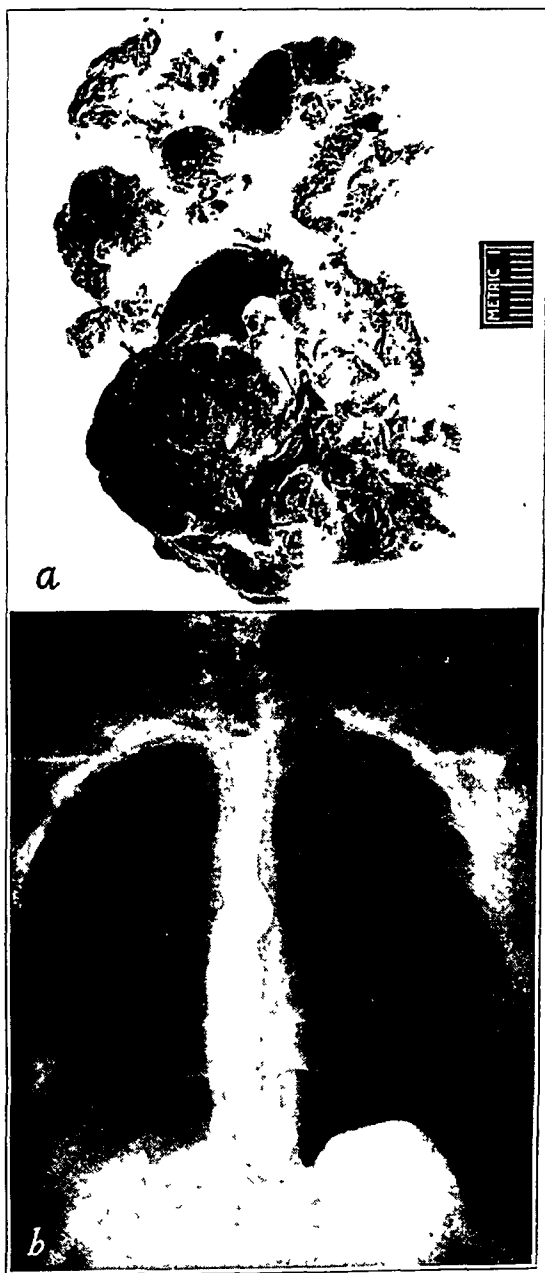


Fig. 2 (same case as in figure 1).—*a*, multicentric leiomyoma involving approximately two thirds of the circumference of the wall of the esophagus, measuring 5.5 by 5 cm. *b*, appearance on dismissal of the patient two months after operation and drainage of localized empyema. Esophagus is irregular at the site of reconstruction but otherwise normal.

It involved at least one half of the circumference of the right anterior and lateral muscular walls of the esophagus. The tumor, which was multicentric, was carefully dissected out of the wall of the esophagus without injury to the mucous membrane. The portion of the wall of the esophagus involved was completely destroyed by the tumor. This fact made it difficult to reconstruct the wall of the esophagus, but this was accomplished with three invaginating rows of silk sutures. The esophagus was considerably dilated at the site of the tumor, which made it possible to accomplish the reconstruction of the wall without obstructing its lumen. After invagination of the esophageal wall, the parietal pleura was accurately sutured for the reconstruction. The pleura attached to the lung was left open so as to drain the mediastinum. The tumor measured 5.5 by 5 by 2.5 cm. (fig. 2 *a*). On microscopic study it was found to be a leiomyoma.

During the patient's postoperative course, empyema developed on the right side, for which an open operation with resection of two ribs was required. His sub-

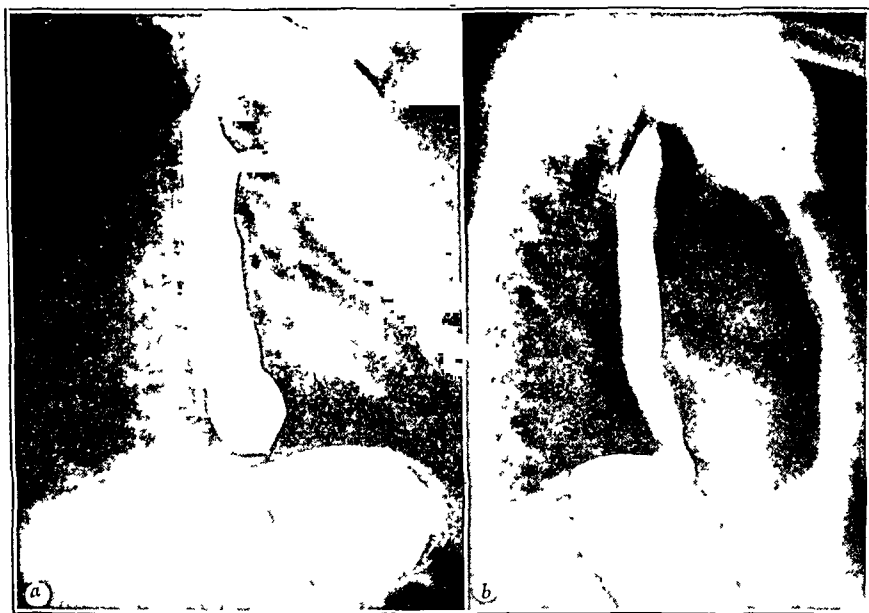


Fig. 3—Intramural leiomyoma of posterior median wall of the lower third of the esophagus. Transpleural esophagotomy on the left side, with resection of tumor and reconstruction of wall of esophagus. *a* and *b*, moderate deformity of the lower part of the esophagus with some obstruction of the lumen shown by lateral roentgenogram on the patient's admission to the clinic.

sequent course was without incident, and at the time of his dismissal, two months after the operation, the cavity was healing well. The roentgenogram of the thorax revealed thickened pleura on the right and the roentgenogram of the esophagus was normal (fig. 2 *b*).

CASE 2—A woman, aged 58 years, consulted the clinic on April 21, 1947, because of attacks of belching of five years' duration. She stated that the belching would occur at any time and had no relation to food. She would have several periods of belching during the day but no pain. Eighteen months prior to her admission to the clinic, she had begun having a feeling of fulness in the lower part of the sternum, followed by a "grinding" sensation. On occasions she would have regurgitation of clear-colored frothy material. She also complained of

choking spells, when food, solid or liquid, would stick in her throat. She would sip water until food would pass on. The symptoms were periodic, troubling her for several days and then she would be free of discomfort for several days. She had no real pain. She had lost 20 pounds (about 9.1 Kg.) during eight to ten months prior to her admission. She had recently consulted her home physician, who diagnosed the condition as a polyp in the esophagus.

On examination at the clinic, the roentgenologic study revealed an intramural tumor involving the posterior medial wall of the lower third of the esophagus, which was thought to be a leiomyoma (fig. 3). Esophagoscopy revealed that the posterior and left lateral walls of the esophagus protruded into the lumen of the esophagus about 2½ inches (about 6 cm.) above the cardia. There was no difficulty in causing the esophagoscope to enter the stomach.

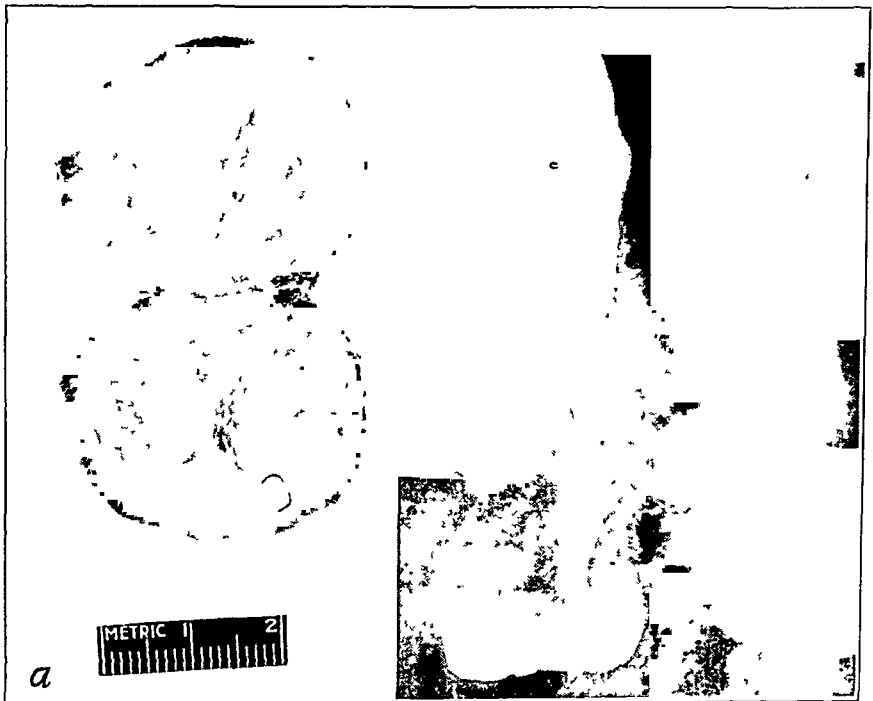


Fig. 4 (same case as in figure 3).—*a*, fairly well circumscribed leiomyoma measuring 35 by 3 cm. *b*, three weeks after operation. Moderate deformity at site of reconstruction of the wall of the lower part of the esophagus.

A diagnosis was made of an indeterminate lesion of the lower third of the esophagus, most likely a leiomyoma, and surgical intervention was advised.

On May 2, 1947, transpleural esophagotomy with complete resection of the tumor and reconstruction of the wall of the esophagus was performed on the left side. A posterolateral incision was made, the posterior two thirds of the seventh rib resected and the angles of the eighth and sixth ribs removed. The lower part of the esophagus was exposed just above the diaphragm, and a single well circumscribed leiomyoma was found in the left lateral wall. The tumor did not involve the mucous membrane, and it was located intramurally. It was carefully dissected from the wall of the esophagus, which was then reconstructed with

interrupted silk and chromic surgical gut sutures. The mediastinal pleura was sutured over the repaired esophagus. Temporary intercostal closed drainage was instituted.

The tumor measured 3.5 by 3 by 2.5 cm. (fig. 4 *a*). On microscopic study it proved to be a leiomyoma.

The patient's postoperative course was entirely uneventful, and she was dismissed from our care on the twenty-sixth postoperative day. The roentgenogram of the thorax revealed slight thickening of the pleura at the left base, and the roentgenogram of the esophagus was normal except for slight irregularity at the site of the operation (fig. 4 *b*).

CASE 3.—A man, aged 53 years, consulted the clinic on June 7, 1948. He gave a history of having had a persistent cough, for which he had consulted his home physician nine years prior to his admission to the clinic. A roentgenographic study had revealed a tumor in the lower third of the esophagus. Subsequent roent-

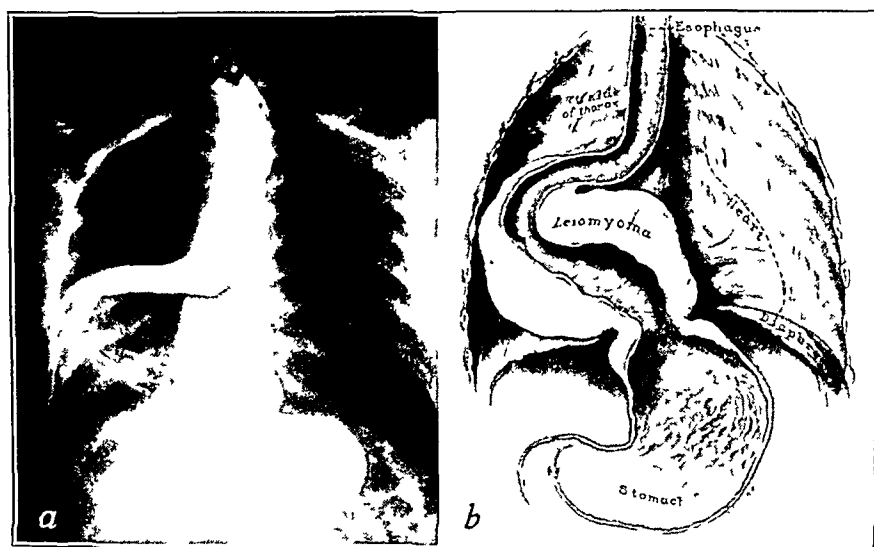


Fig. 5.—*a*, diffuse leiomyoma of the lower third of the esophagus and the cardiac fourth of the stomach. Transpleural and transdiaphragmatic resection of the lower half of the esophagus and the cardiac third of the stomach, with esophago-gastroanastomosis, was performed on the right side. Roentgenogram on admission shows marked displacement of the lower half of the esophagus into the right thoracic cavity and questionable esophageal hiatal hernia. *b*, at operation, showing position of the diffuse leiomyoma of the entire muscular wall of the lower third of the esophagus, extending into the outer wall of the cardiac fourth of the stomach.

genograms in 1941, 1943 and 1946 revealed no change in the size of the tumor. A recheck in 1948 revealed that it had increased from 4 cm. in diameter to about 10 cm., with pressure on the esophagus and displacement of it. The opinion was that it was either a posterior mediastinal tumor displacing the esophagus or an intramural tumor of the esophagus. The patient had not experienced loss of weight, and the only symptom was sharp sudden pain in the lower part of the thorax, on the right side of the spinal column, of a few seconds' duration.

On examination at the clinic the roentgenogram of the thorax revealed a rounded mass in the right posterior-inferior mediastinum. The roentgenogram of the esophagus revealed a tumor in the right lower quadrant of the thorax attached

to the esophagus and distorting its lower end, retracting it somewhat to the right. It was thought to be an intramural tumor or a small esophageal hiatal hernia. Esophagoscopy revealed that the esophagus was obstructed by an extraesophageal mass. It was otherwise normal.

A diagnosis was made of a posterior mediastinal tumor extending into the right lower quadrant of the thoracic cavity and distorting the lower part of the esophagus or a leiomyoma of the lower part of the esophagus, and exploration was advised.

On June 28, 1948, transpleural esophagotomy with complete resection of the tumor and reconstruction of the esophagus was performed on the right side. A posterolateral incision was made on the right, with resection of the seventh rib and the angles of the sixth and eighth ribs. The pleural cavity was entered through the posterior periosteum of the seventh rib. On exploration of the lower part of the thorax, a large tumor was found involving the lower 5 inches (about 13 cm.) of the esophagus and infiltrating two thirds of the right wall of the esophagus. The tumor, which was multicentric, was enucleated from the wall of the esophagus.



Fig. 6 (same case as in figure 5).—*a*, technic of transpleural esophagogastric anastomosis on the right; *b*, one month after operation. Half of stomach above the diaphragm. Esophagogastric anastomosis free.

There was considerable fixation of the mucous membrane in the center of the tumor, and it was necessary to resect about 3 cm. of the mucous membrane with the tumor. The mucous membrane was then closed with inverting sutures of silk and continuous surgical gut. The wall of the esophagus was then reconstructed, and the mediastinal pleura was sutured over the closure. Transcostal closed drainage was established after resection of a segment of the ninth rib.

The tumor measured 10 by 7.5 by 5.5 cm. On microscopic study it proved to be a leiomyoma.

The patient's postoperative course was without incident. He was dismissed from the clinic on the twenty-seventh postoperative day. The roentgenogram of the esophagus revealed postoperative changes in the lower end and a small esophageal hiatal hernia.

CASE 4.—A woman, aged 19 years, consulted the clinic on May 6, 1947. She complained of choking spells of three years' duration. In April 1944 she had had a burning sensation in the epigastric region and also a choking sensation accom-

panied with a feeling of not being able to swallow or to get sufficient air into the lungs. Her symptoms progressed for two years. A roentgenogram was then taken by her home physician, who made a diagnosis of diaphragmatic hernia and referred the patient to the clinic. At the time of her admission she had spells of choking on solid food when eating rapidly but not when taking liquids. She had no pain but a burning sensation in the substernal region.

On examination at the clinic the roentgenogram of the chest revealed a mass in the lower lobe of the right lung near the midline, extending laterally just above the diaphragm and containing a segment of the alimentary tract. The roentgenogram of the esophagus revealed marked displacement of the lower half to the right (fig. 5 *a*), which was thought to be due to extrinsic pressure. The opinion of the roentgenologist was that the lesion was either a large mediastinal tumor or a hiatal diaphragmatic hernia. Esophagoscopy revealed considerable angulation of the esophagus to the right at the junction of the middle and upper thirds. There seemed to be a firm mass underlying the esophagus. It was impossible to determine whether it was an intrathoracic tumor extrinsic to the esophagus and displacing it or a tumor of the wall of the esophagus, as the esophagoscope could not be introduced beyond the middle third because of the angulation.

Since it was impossible to make a definite preoperative diagnosis, transthoracic exploration was advised. On June 20, 1947, transthoracic and transdiaphragmatic exploration was carried out on the right side, with resection of the lower half of the esophagus and the cardial third of the stomach, followed by esophagogastric anastomosis. A posterolateral incision was made in the right lower quadrant of the thorax, with resection of the eighth rib and of segments of the seventh and ninth ribs. On exploration of the thoracic cavity, a large tumor was found displacing and partially obstructing the esophagus. It involved at least the lower third of the esophagus and the cardial fourth of the stomach (fig. 5 *b*). The tumor involved the entire circumference of the esophagus as well as the entire circumference of the cardia and extended along the lesser curvature of the stomach. It was necessary to resect the lower half of the esophagus and the cardial third of the stomach. This resection was followed by an esophagogastric anastomosis (fig. 6 *a*). The esophagus was markedly thick walled, making the anastomosis difficult, but a satisfactory one was accomplished. The tumor measured 8 by 5 by 3 cm. On microscopic examination it proved to be a leiomyoma of a diffuse type which may be termed a leiomyomatosis of the entire muscle wall of the esophagus. It did not involve the mucous membrane.

The patient's immediate convalescence was complicated by an irregular pulse and tachycardia, which improved after the fourth postoperative day, and her further course was satisfactory. She was dismissed on the twenty-fourth postoperative day. The roentgenogram of the esophagus revealed resection of the lower half of the esophagus and of one half of the remaining portion of the stomach above the diaphragm. The esophagogastric anastomosis was functioning freely (fig. 6 *b*). She returned one year after the operation, at which time her condition was satisfactory.

CASE 5.—A woman, aged 60 years, consulted the clinic on May 24, 1945, complaining of dysphagia and substernal pain of one year's duration. She stated that for the past year she had had increasing dysphagia associated with substernal pain, both of which had become severe. For six months she had had regurgitation of food while eating. This was occasionally associated with hemoptysis. For the past few months she had had some hoarseness. She also had had considerable dyspnea on physical effort, with some edema of her legs for several years.

On examination at the clinic, a roentgenogram of the esophagus and stomach revealed a tumor involving the distal third of the esophagus and extending to the cardia, displacing the esophagus to the left and anteriorly (fig. 7*a*). The esophagoscopic examination showed an ulcerating polypoid lesion, which was extremely friable and necrotic, partially obstructing the lower third of the esophagus. Tissue was removed for biopsy and was reported as a malignant lesion, grade 4 (Broders' method), probably sarcoma.

Although the patient was a poor operative risk because of hypertension with cardiac damage and obesity, it was felt that operation was justified because of the impending complete obstruction.

On June 16, 1945, transthoracic and transdiaphragmatic resection of the lower half of the esophagus and the cardial end of the stomach and esophagogastric anastomosis were performed. A posterior lateral incision was made on the left,



Fig. 7.—Diffuse leiomyosarcoma involving the lower third of the esophagus. Transpleural and transdiaphragmatic resection of the lower half of the esophagus and the cardial end of the stomach, with esophagogastric anastomosis, on the left side. *a*, tumor of the lower third of the esophagus extending to the cardia, displacing the esophagus to the left, with partial obstruction of the esophagus; *b*, at operation, showing diffuse leiomyosarcoma involving the lower third of the esophagus and technic of esophagogastric anastomosis.

with resection of the posterior two thirds of the ninth rib. The pleural cavity was opened through the posterior periosteum of the rib. The lower part of the esophagus was exposed by incising the mediastinal pleura, which revealed a large oval tumor involving the lower third (fig. 7*b*). The tumor had the gross appearance of a multicentric diffuse type of leiomyoma. The esophagus above the tumor was separated from the surrounding mediastinal structures, and a piece of tape was placed around it above the tumor. The left phrenic nerve was cut, relaxing the diaphragmatic muscle. An incision was made through the anterolateral portion of the diaphragm extending through the esophageal hiatus. The stomach was then mobilized and the cardial 3 inches (about 8 cm.) was resected with the lower third

of the esophagus which was involved by the tumor. An esophagogastric anastomosis was made with the interrupted silk sutures and continuous chromic surgical gut. It was necessary to bring about two thirds of the stomach above the diaphragm in order to make the anastomosis without tension on the suture line. The opening

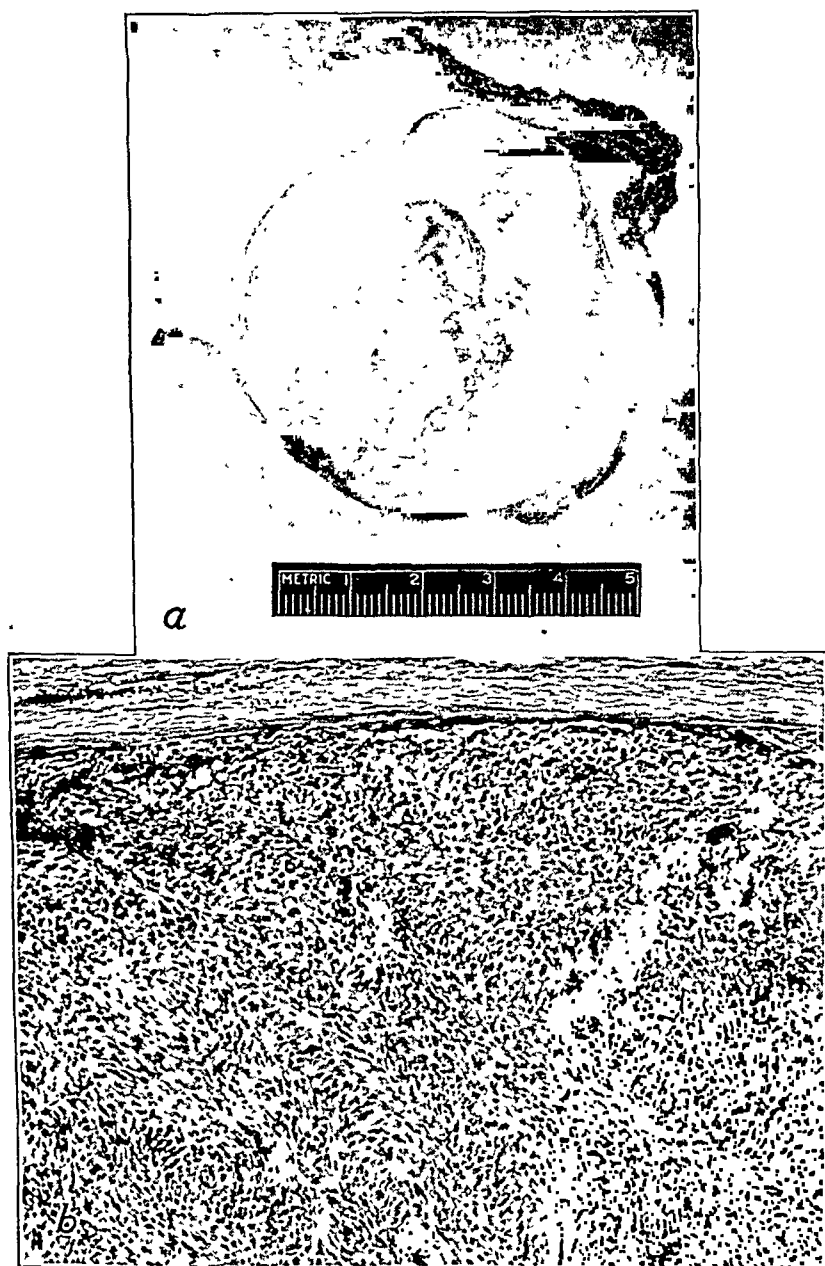


Fig. 8 (same case as in figure 7).—*a*, diffuse leiomyosarcoma; *b*, leiomyosarcoma, grade 4; $\times 75$.

in the diaphragm was then partially closed, and the remaining opening was sutured to the walls of the stomach. The thoracic wall was closed with transcostal closed drainage through the posterior periosteum of the ninth rib.

The tumor measured 6 by 5.5 by 4.5 cm. (fig. 8 *a*). The microscopic study revealed a leiomyosarcoma, grade 4, invading and ulcerating the mucous membrane (fig. 8 *b*).

The patient's convalescence was satisfactory. The tube was removed from the pleural cavity on the fifth day. On the seventh day the temperature was elevated to 100 F. A roentgenogram revealed some signs of fluid in the left pleural cavity, and pleurocentesis was done, with removal of 200 cc. of clear fluid, which was sterile on culture. The temperature returned to normal. The patient was placed on a soft diet at the end of one week. She was dismissed six weeks after the operation, at which time she was taking a normal diet without difficulty. The roentgenogram revealed that the anastomosis between the esophagus and the stomach was entirely free and approximately two thirds of the stomach was above the diaphragm (fig. 9).

CASE 6.—A woman, aged 60 years, consulted the clinic on Sept. 23, 1948, complaining of difficulty in swallowing of three weeks' duration. She stated that



Fig. 9 (same case as in figure 7).—Roentgenogram made on dismissal of the patient six weeks after operation. Resection of the lower third of the esophagus was carried out. Two thirds of the stomach is above diaphragm. Esophagogastric anastomosis free.

she had had a sensation of solid food sticking in her throat for the past week. She gave little attention to this but did mention it to her physician while being attended for eye refraction. She had had no vomiting but had regurgitated some mucus. She had had no pain. Only liquids and soft food had been taken for the previous two weeks. These were ingested with ease as long as they were taken slowly. A roentgenogram made by her home physician revealed an obstructing lesion of the lower end of the esophagus.

On examination at the clinic a roentgenogram of the thorax revealed a fusiform shadow overlying the mediastinum and extending below the diaphragm. This was thought to be a dilatation of the lower part of the esophagus or possibly a carcinoma of the cardia with esophageal obstruction. The roentgenogram of the esophagus revealed a carcinoma involving the lower third and the cardiac end of the stomach.

Esophagoscopy revealed a large polypoid tumor mass in the lower part of the esophagus. A biopsy revealed a leiomyosarcoma, grade 3.

A left transpleural exploration was advised. The procedure was carried out on October 1. A posterolateral incision was made, with resection of the posterior three fourths of the seventh rib and removal of the angles of the sixth and eighth ribs. The pleural cavity was opened through the posterior periosteum of the seventh rib. There was a small amount of fluid in the left pleural cavity. On exploration of the lower part of the esophagus, it was found that there was a large edematous tumor involving the lower half of the esophagus. There was pronounced edema in all the surrounding tissues, with infiltration of the tumor into the pericardium and into the wall of the descending aorta. The upper portion of the tumor had infiltrated the wall of the pulmonary vessels and the bronchus of the left lung. There was notable fixation to the diaphragm. Tissue removed from the region of the extension proximal to the wall of the aorta was reported as leiomyosarcoma, grade 3. Because of the extensive involvement of the esophagus, with invasion into the surrounding structures, the condition was inoperable, and the chest was closed, with transcostal closed drainage established through the posterior periosteum of the seventh rib.

The patient's postoperative course was satisfactory. Some difficulty in swallowing solid food developed, and the esophagus was dilated. She returned home on the twenty-fourth postoperative day. She was placed on a bland diet, which she could take without difficulty. However, she was advised that further dilations would probably be necessary subsequently.

COMBINED DATA ON ELEVEN CASES

The following is a summary of the 11 cases of tumor of the esophagus in which I have operated, 5 of which were previously reported and the remaining 6 reported in the present paper.

Among the entire series of 11 cases, in 2 the tumors were submucosal pedunculated benign tumors extending into the lumen of the esophagus. One of these was a lipoma covered with normal mucous membrane originating from a single pedicle at the introitus and extending to the cardia of the stomach; the other consisted of two large fibromyomas covered with normal mucous membrane, and each had a separate long narrow pedicle which originated from a single pedicle at the introitus of the esophagus.

Nine of the tumors were intramural tumors originating from the muscle of the wall of the esophagus. Seven of these growths were benign leiomyomas and 2 (18 per cent of the total 11 cases) were malignant leiomyosarcomas. The 7 benign leiomyomas involved only the muscular coat of the esophagus and did not involve the mucous membrane. Five were in the lower third and 2 were in the middle third of the esophagus. They were of three types according to gross characteristics. One was a single, completely encapsulated, circumscribed growth, involving a relatively small segment of the outer esophageal wall; 4 were multiple leiomyomas of multicentric origin involving a large segment and from one third to two thirds of the circumference of the wall of the esophagus;

the remaining 2 were a diffuse type of multiple leiomyoma, which may be termed "leiomyomatosis," involving the entire circumference of the outer wall of the lower part of the esophagus and for a longitudinal distance of from 3 inches (about 8 cm.) to one third of the entire length of the esophagus. One of these growths extended into the cardia of the stomach.

The 2 malignant growths or leiomyosarcoma were of the diffuse type involving the entire circumference of the lower 3 to 5 inches (about 8 to 13 cm.) of the esophagus and also invaded the mucous membrane, producing areas of necrosis and ulceration.

Of the entire series of 11 patients, 6 were women and 5 were men. The youngest was 19 and the oldest 60 years of age. The average age was 44 years.

The duration of symptoms was one to fifteen years. Five of the 11 patients presented symptoms of esophageal obstruction. Of these, 2 had an intramural pedunculated benign growth, 2 a malignant growth and the remaining patient a benign intramural tumor markedly distorting and involving the lower third of the esophagus as well as the cardial fourth of the stomach.

In only 1 case was there any hemorrhage from the lesion, and in that case the lesion was malignant. In 2 cases the tumor appeared in the mouth during forceful vomiting. In each of these cases the tumor was a pedunculated benign submucosal growth.

The surgical procedures carried out in the 11 cases of this series were as follows: The 2 submucosal pedunculated tumors were completely removed after the pedicle had been cut and ligated at their origin after performance of esophagotomy, 1 through a left cervical approach and 1 through a right posterolateral transpleural approach. The 7 benign intramural leiomyomas were completely removed, 5 by excision of the tumor from the muscular wall of the esophagus and reconstruction of the remaining portion of the wall of the esophagus. In 3 of these 5 cases the tumor was excised extramucosally, and in 2 the mucosa was extremely thin and was incised and closed, with the reconstruction of the outer wall of the esophagus. The approach for these 5 tumors was right transpleural in 3 cases, left transpleural in 1 case and left abdominal in 1 case. In the remaining 2 cases of benign lesions the tumor involved the entire wall of the lower part of the esophagus, 1 involving the cardia of the stomach also. These 2 tumors were completely removed by transpleural and transdiaphragmatic resection of the lower part of the esophagus and the cardial end of the stomach, with esophagogastronomy. The approach for 1 was through the right thoracic cavity and for the other through the left thoracic cavity.

The 2 malignant leiomyosarcomas were operated on through a left posterolateral transthoracic approach. In 1 case the tumor was found to

be inoperable because of the extension of the malignant lesion into the mediastinal structures and the wall of the aorta. In the remaining case the tumor was completely removed by transthoracic and trans-diaphragmatic resection of the lower part of the esophagus and the cardia of the stomach followed by esophagogastronomy.

SUMMARY

In 1 of 2 cases of malignant tumors, the lesion was inoperable and the patient continues to have trouble but is being partially relieved by esophageal dilations. The other patient with a malignant lesion was completely relieved after operation and has progressed satisfactorily without further trouble during three years after operation.

The results obtained in the 9 cases in which the tumor was benign are as follows: In 1 case bilateral pneumonia developed postoperatively and the patient died on the fourth day. In 2 cases localized empyema developed postoperatively. Drainage of the empyema was followed by complete recovery. Six patients had no postoperative complications and made complete recoveries from the operation.

One patient died, in 1 case the lesion was inoperable and 9 patients recovered from operation and have been relieved of symptoms.

SURGICAL TREATMENT OF CARCINOMA OF THE ESOPHAGUS AND STOMACH

HAROLD LINCOLN THOMPSON, M.D., Ph.D.

LOS ANGELES

WHILE surgery has made extraordinary advances on several fronts during the last decade, one of the most significant is the trans-thoracic attack on lesions of the esophagus and gastric cardia. Thus by the expedient of a new approach, one of the greatest needs in surgical treatment of malignant disease has been fulfilled.

In order to appreciate this, it is only necessary to refer to the vital statistics of the United States.¹ In the year 1945 there were 3,100 deaths from cancer of the esophagus while deaths from carcinoma of the stomach numbered 25,832. If it was true then as now that an estimated 10 per cent of all cancers of the stomach occurred in or involved the cardia, there were 2,583 cases of carcinoma of this region. Thus, if to the 3,100 carcinomas of the esophagus are added 2,583 carcinomas of the cardia, there were in 1945 a total of 5,683 cases in which carcinoma occurred at the esophageal and cardiac levels. This total represents the number which had they occurred seven years previously would have been classified by roentgenologists as "inoperable" according to the practice of that period. Whereas gastric cancer now heads the list in frequency, cancer of the esophagus continues to be more common than cancer of the lip, tongue, mouth, pharynx, larynx, thyroid or kidney or all malignant tumors of bone. In view of these vital statistics, the significance of this most recent approach to surgical treatment of malignant disease of the upper part of the alimentary tract immediately is apparent.

ANATOMY

Complete agreement among students of anatomy of the human stomach does not exist. Anatomic concepts vary with the point of view of the observer. Thus descriptive gross anatomy varies from histologic and physiologic anatomy. Clinically, there are the surgical, the roentgenologic and the gastroscopic concepts of anatomy, each having its legitimate place according to the circumstances in which

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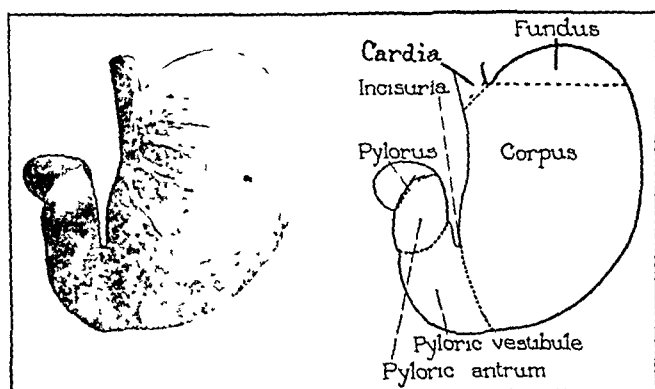
1. Vital Statistics of the United States, 1945, United States Public Health Service, National Office of Vital Statistics, 1947, pp. 1-10.

anatomic observations are made. It is not always possible, therefore, to reconcile divergent points of view into a single descriptive anatomy of the human stomach.

One of the greatest points of variance anatomically is with respect to the gastric cardia. Few anatomists state precisely what the limits of the cardia are. Thus in the same text one author refers to the cardia as the "region of the junction of the esophagus with the stomach" and illustrates it as that entire portion of the stomach proximal to the incisura.

Previously I² have pointed out the following facts:

Histologic and physiologic investigations have demonstrated that the simple stomachs of mammals are divided into different parts with different functions and properties. There are two great divisions of the simple stomach, the plane of demarcation being indicated by the incisura angularis (figure). These divisions



Drawing of the stomach indicating its subdivisions. The cardia is incompletely defined grossly but clearly delimited histologically as an annular zone approximately 5 mm. in width surrounding the esophageal orifice of the stomach.

are the proximal portion, named the fundus, and the distal portion, called the pylorus. The fundus is divided into the cardia, a narrow zone about the esophageal orifice, and the corpus or prepyloric portion occupying the region between the cardia and the incisura. The pylorus is divided into three subdivisions; a proximal portion, the pyloric vestibule; an intermediate portion, the pyloric antrum; and a distal portion or pyloric canal formed by the pyloric sphincter. . . . The cardia is lined by columnar epithelium containing mucous glands which resemble those of the pylorus.

The cardia, therefore, while being grossly the general and incompletely defined region of the esophageal entrance is, on the other hand, clearly delimited on a histologic basis as an annular zone approximately 5 mm. in width surrounding the orifice of the esophagus. The glands of the cardia may be regarded as modified fundus tubules having cells which

2. Thompson, H. L.: Studies on the Surgery of the Stomach, Thesis, University of Minnesota, 1930, pp. 7-9

resemble the chief cells of the gastric tubules along with a few parietal cells and in addition the distinctive tubules which recall the intestinal crypts of Lieberkühn.

From the foregoing it is clear that the mucous membrane of all portions of the stomach, including the cardia, is of the glandular type. In contradistinction to this, the mucous membrane of the contiguous esophagus is of the squamous epithelial variety. This important distinction between the histologic nature of the esophagus and that of the cardia has significant pathologic and, therefore, clinical implications.

SURGICAL ANATOMY

Malignant disease existing in the gastric cardia or the distal esophagus presents the same surgical problem. The transthoracic approach now has made accessible to surgical attack these two previously almost inaccessible organs. Thus, while differing in structure and function, these viscera constitute a single surgical region. With the exception of Garlock,³ most writers treat them as a single anatomic or therapeutic region. He is the only extensive writer who is consistent in his differentiation between lesions of the esophagus and those of the stomach. His distinction is based chiefly on the histopathologic nature of the respective malignant lesions.

While it cannot be denied that the pathologic process is a sound basis for such distinction, there are several reasons why consideration of the surgery of these two regions together should be continued: First, the esophagus and the cardia are contiguous anatomically. Second, the most frequent early symptom of a lesion existing at either site is dysphagia. Third, diagnostic confirmation usually is dependent on esophagoscopy with biopsy. Fourth, successful removal of a given malignant lesion is dependent on excision of a portion of the esophagus or the stomach or both. Thus, from an anatomic, symptomatic, diagnostic and therapeutic standpoint, the contiguous portions of the esophagus and stomach constitute a single surgical region.

Anatomically there are three types of lesion accessible by the transthoracic approach, namely, lesions of the esophagus and the cardia and lesions of the body or fundus of the stomach which extend to the cardia.

PATHOLOGIC PROCESS

It has been stated that Garlock³ reported his surgical procedures on the esophagus and gastric cardia on a histopathologic basis. Since the mucosa of the esophagus is squamous in type, carcinoma originating in this organ is of the corresponding squamous cell variety. Since, on

3. Garlock, J. H.: The Problem of Cancer of the Esophagus, *J. Mt. Sinai Hosp.* 7:349-352, 1940.

the contrary, the mucosa of the cardia is glandular, carcinoma of this region is adenocarcinomatous in type. Aside from the histologic distinction between the two types of carcinoma, the most characteristic difference is in the mode of spread. Adenocarcinoma of the stomach tends to spread to the esophagus directly and through the submucosal layer. Less frequently squamous cell carcinoma of the esophagus spreads to the stomach by direct invasion on the one hand and to the paracardial lymph nodes on the other. Perhaps the only exception which can be taken to these pathologic distinctions is the theoretic possibility of the origin of adenocarcinoma from rests of gastric mucosa situated in the esophagus.

NOMENCLATURE OF OPERATIVE PROCEDURES

In view of these anatomic and pathologic considerations, I believe that, in the reporting of additional cases, attention should be given to the nomenclature of the operative procedures employed. Since the distal portion of the esophagus and the proximal end of the stomach constitute one surgical region, there is no reason to abandon the present practice of reporting cases of carcinoma of the respective areas together in the surgical literature. In order, at the same time, to distinguish lesions arising in the esophagus from those originating in the stomach, irrespective of extension from one organ to the other, I should like to suggest the employment of two new terms. I would suggest the term esophagocardectomy for surgical removal of lesions primary in the esophagus and cardioesophagectomy for lesions originating in the cardia. This distinction is made in the series of cases reported here. In the future, as the number of cases in the literature increases, refinement in nomenclature should become increasingly important.

HISTORY

The history of esophagectomy and cardectomy appears to be of interest. I have divided the history into four periods accordingly as each period is characterized by a significant development in this field of surgery.

The first period dates from 1871 to 1906: In 1871 Billroth⁴ performed esophagectomy in animals and thereby proved that the procedure was feasible. This was ten years before his pupil, Wölfler,⁵ performed the first successful operation (gastrojejunostomy) on the human stomach. It is of interest also to note that in 1877 Czerny,⁶

4. Billroth, T.: Ueber de Resection des Oesophagus, Arch. f. klin. Chir. 8:65, 1871.

5. Wölfler, A.: Gastroenterostomie, Zentralbl. f. Chir. 8:705-708, 1881.

6. Czerny: Neue Operationen, Centralbl. f. Chir. 4:433, 1877.

also Billroth's pupil, performed the first cervical esophagectomy. The patient survived. In 1895 Biondi^{6a} performed transthoracic esophagogastronomy on dogs. He apparently was the first to advance the stomach into the thorax. In 1898 Mikulicz⁷ reported having performed transabdominal cardiectomy on a human being, but the patient did not survive. In 1904 Mikulicz,⁸ using the Sauerbruch positive pressure chamber, performed transthoracic cardiectomy on a dog. The animal survived the operation for four weeks but died of inanition from implied stenosis at the anastomosis but without evidence of intrathoracic complication. The author pointed out that such a complication in man doubtless could be treated successfully by bougienage. More important than this, however, was the fact that the author, using the same technic on another animal, demonstrated the practical possibility of advancing the stomach into the thorax. At the time of his report, the animal was living six weeks after operation and appeared to be in excellent health. Wendel^{8a} in 1906 performed transthoracic cardiectomy with esophagogastronomy by use of the Murphy button. He reported his case as the first technically successful transpleural esophagogastronomy.

The second period begins in 1908 and extends over the decade to 1918. This period is marked by the successful performance of cardiectomy and esophagectomy in human beings, with survival of the patients. In 1908 Voelcker⁹ of Heidelberg performed successful transabdominal cardiectomy on a 64 year old woman. In 1912 Torek¹⁰ of New York performed the first successful transthoracic esophagectomy. The patient survived twelve years after resection and died of pneumonia at the age of 80 years without demonstrable recurrence of the malignant lesion at autopsy. In 1916 and 1918, respectively, Brun¹¹ and Bircher¹² reported survivals following transabdominal cardiectomy.

6a. Biondi, A.: *Suppl. al Policlin.* **1**:964, 1895.

7. Mikulicz, J.: *Beiträge zur Technik der Operation des Magencarcinoms*, *Arch. f. klin. Chir.* **57**:524-532, 1898.

8. Mikulicz, J.: *Ueber Operationen in der Brusthöhle mit Hilfe der sauerbruchschen Kammer*, *Deutsche med. Wchnschr.* **30**:530-532 and 577-579, 1904.

8a. Wendel, W.: *Beitrag zur endothorakalen Oesophaguschirurgie*, *Arch. f. klin. Chir.* **83**:635-647, 1907.

9. Voelcker: *Ueber Extirpation der Cardia wegen Carcinoms*, *Verhandl. d. deutsch. Gesellsch. f. Chir.* **37**:126-129, 1908; *Zentralbl. f. Chir.* **37**:90-92, 1908.

10. Torek, F.: *The First Successful Resection of the Thoracic Portion of the Esophagus for Carcinoma*, *J. A. M. A.* **60**:1533 (May 17) 1913.

11. Brun, H.: *Ueber die Bedeutung der Unterbindung der Arteria coronaria sinistra bei Resektionen des Magens insbesondere der Kardia*, *Deutsche Ztschr. f. Chir.* **135**:81-100, 1916.

12. Bircher, E.: *Operative Heilung eines Carcinoms am Übergang des Oesophagus in der Cardia*, *Cor.-Bl. f. Schweiz., Aertze* **48**:467-478, 1918.

The third period in the history of these procedures extends for a brief five years, from 1933 to 1938. In 1933 Ohsawa¹³ reported 2 cases of abdominothoracic esophagectomy, in 1 of which the patient survived. In 1937 Marshall¹⁴ performed the first recent transthoracic cardio-esophagectomy, with survival. In the following year Cattell¹⁵ in 1 case and Ochsner and DeBakey¹⁶ in another case performed successful cardioesophagectomy. In 1938 Adams and Phemister¹⁷ performed the first single stage transthoracic esophagocardiectomy, with survival. At the time of this writing their patient is living,¹⁸ ten years and ten months after operation. This work thus is credited with having inspired the modern endeavors in this difficult field.

The fourth and recent period extends from 1939 to 1947. On April 27, 1939, Garlock¹⁹ performed his first single stage esophago-gastrostomy, with survival. Garlock deserves great credit for having perfected and modified, prior to that report, the Torek technic of operation whereby in 1938 he was able to report 3 successful cases.²⁰ By 1940¹⁹ he had to his credit six successful operations by the modified Torek technic and one survival by the method under present consideration. In 1939 Churchill and Sweet²¹ began their work, which has continued uninterruptedly to date. Sweet's contributions to the technical phases of the transthoracic approach have been outstanding. In addition he has the largest series of cases reported. In my opinion, this period closed in 1947, when Sweet²² stated that the phase of technical development had ended and that the period of statistical evaluation of the various operative procedures had begun.

13. Ohsawa, T.: The Surgery of the Esophagus, *Arch. f. jap. Chir.* **10**:605, 1933.

14. Marshall, S. F.: Carcinoma of the Esophagus: Successful Resection of the Lower Third of Esophagus with Re-establishment of Esophageal Gastric Continuity, *S. Clin. North America* **18**:643-648, 1938.

15. Cattell, R. B.: Resection of the Lower Esophagus for Carcinoma, *S. Clin. North America* **21**:649-655, 1941.

16. Ochsner, A., and DeBakey, M.: Surgical Aspects of Carcinoma of the Esophagus, *J. Thoracic Surg.* **10**:401-445, 1940.

17. Adams, W. E., and Phemister, D. B.: Carcinoma of the Lower Thoracic Esophagus, *J. Thoracic Surg.* **7**:621-632, 1938.

18. Phemister, D. B.: Personal communication to the author.

19. Garlock, J. H.: The Surgical Treatment of Carcinoma of the Thoracic Esophagus, *Surg., Gynec. & Obst.* **70**:566-569, 1940.

20. Garlock, J. H.: The Surgical Treatment of Carcinoma of the Thoracic Esophagus, *Surg., Gynec. & Obst.* **66**:534-548, 1938.

21. Churchill, E. D., and Sweet, R. H.: Transthoracic Resection of Tumors of the Stomach and Esophagus, *Ann. Surg.* **115**:897-920, 1942; **116**:566-573, 1942.

22. Sweet, R. H.: Carcinoma of the Esophagus and Cardiac End of the Stomach, *J. A. M. A.* **135**:485-490 (Oct. 25) 1947.

CLINICAL FEATURES

At onset, the symptoms from carcinoma of the esophagus and cardia, while characteristic, usually are so mild that the patient frequently assumes erroneously that they originate from benign disturbance of the gastrointestinal, circulatory or even respiratory tracts. The earliest and usually the most persistent symptom is dysphagia. In the beginning it usually is mild, transitory or recurring. It arises from obstruction to the passage of food through the esophagus and into the stomach. Obstruction at these higher levels in the gastrointestinal tract is relievable by regurgitation and thus never amounts to the acute forms of obstruction such as occur beyond the pylorus. Neither is it associated with the marked dilatation and elongation of the esophagus seen in the chronic form of obstruction associated with cardiospasm. Ultimately the dysphagia progresses until it becomes distressing to the patient. His first visit to the physician often is deferred until this time.

While pain is not usual, it is, paradoxically, not an uncommon symptom. Usually it appears late and probably results from extension of or infection in the neoplastic growth. Occasionally bleeding, as manifested by hematemesis or melena, is the first symptom noted. If the patient presents himself early, the physician, therefore, must be alert to the possibilities of the mild symptoms.

In the later stages, while there may be pain or chronic anemia, the most characteristic feature is progressive loss of weight. At this stage and despite the lowering of general morale induced by starvation, the patient usually is eager to assume the risk of an extensive surgical procedure in order to obtain relief.

DIAGNOSIS

The diagnosis of carcinoma of the esophagus or cardia usually is based on a history of persistent dysphagia combined with characteristic roentgenologic and endoscopic findings. In my experience pain has been a significant symptom in fewer than half the cases. Except for evidences of loss of weight or bleeding, the physical findings commonly are insignificant. Fluoroscopy is of the utmost value in detecting the presence of a lesion of the esophagus or gastric cardia. Occasionally, however, especially if situated at the cardia, the lesion escapes detection by fluoroscopy, whereon diagnostic esophagoscopy or gastroscopy must be relied on. In view of the fact that relief in these cases requires extensive surgical procedure, it is not only desirable but obligatory to confirm the roentgenologic findings by endoscopy. Biopsy furnishes valuable and final proof of the existence of a malignant process.

TRANSTHORACIC AND ABDOMINOTHORACIC APPROACHES

During the last half decade, the transthoracic approach has become established in gastric and esophageal surgery. Thus many patients who, prior to a decade ago, were denied the benefits of surgical relief, if they were living now might find their condition amenable to it. Moreover, this approach has permitted improvement in the technic of certain other procedures as, for example, total gastrectomy and the surgical treatment of cardiospasm and stricture of the esophagus.

A logical extension of the transthoracic route is the abdominothoracic approach to lesions primary in the corpus, cardia, or terminal part of the esophagus or where there is possibility of extensive metastasis to the upper part of the abdomen. In fact, one of the first successful operations of the recent period, performed by Ohsawa¹⁸ in 1933, was approached abdominothoracically. It was his report that led Phemister¹⁸ and his associates to attack the problem of esophageal surgery, which resulted in their performance of the first successful single stage esophagogastrectomy with the result that the patient is living now, ten years and ten months after operation. Since that time the value of the combined approach has been emphasized by Garlock.²³ He enumerated several advantages: (1) that operability may be determined through a small upper left rectus incision before making the incision into the thorax; (2) that in no other way, prior to opening the thorax, may the surgeon determine the presence or absence of hepatic metastasis, fixation of the growth, the presence of peritoneal implants on the diaphragm or in the pelvic peritoneum or extensive retroperitoneal involvement as in the all-important area about the celiac axis.

The success of these approaches to the surgery of the alimentary tract is the result of important technical advances in anesthesiology, thoracic surgery, the care of the depleted patient, the application of antibiotic therapy and chemotherapy and the successful handling of pulmonary and vascular complications. The wide exposure of the esophagus and proximal portion of the stomach makes these operations ideal for resection of lesions involving the esophagus, the cardia, the body and the fundus of the stomach. Without question, they are the best approaches for total gastrectomy because of the excellent exposure they provide for the removal of involved lymph nodes and contiguous structures and for esophagojejunal anastomosis. The advantages with respect to lesions in the stomach are, first, that they permit total gastrectomy if needed and, second, that they permit resection of the proximal portion of the stomach, with preservation of the distal portion in cases in which total gastrectomy otherwise might be required. With

23. Garlock, J. H.: Combined Abdominothoracic Approach for Carcinoma of Cardia and Lower Esophagus, *Surg., Gynec. & Obst.* 83:737-741, 1946.

respect to carcinoma of the esophagus, they replace the Torek operation, which no longer is adequate and thus is obsolete.

PREPARATION OF THE PATIENT

In the early cases, loss of weight and anemia usually are insignificant and thus require little attention during the period of preparation of the patient for operation. In late cases, however, malnutrition may be severe, and steps must be taken to correct it. Dehydration and hypoproteinemia may be correctable by the intravenous administration of dextrose, electrolytes and amino acids. Occasionally, however, the prolonged delay required to correct severe hypoproteinemia is not warranted, and one must proceed with surgical intervention before the condition is overcome entirely. In patients in whom anemia is a problem, infusion of red blood cell concentrates or of whole blood may be required. If obstruction is complete, it may be necessary to wash out the esophagus daily. Appropriate doses of liver extract and vitamins B and C should be given for several days prior to operation. For twenty-four hours before operation sulfadiazine and penicillin are administered, and 0.5 Gm. of streptomycin in solution is given by mouth. A Levin tube is inserted on the morning of operation, and the entire thorax, axilla and abdomen must be shaved so that, if necessary, the incision may be extended upward or downward.

ANESTHESIA

A competent anesthetist is indispensable to the successful application of this type of surgical procedure. Not only must the anesthesia be adequate but the condition of the patient must be entrusted to his care for a period of four or five hours. Not only must anesthesia be maintained but the patient's circulatory and respiratory systems must be kept under constant observation. The anesthetist must be adept at intra-tracheal technic, and he must understand the pharmacology of the newer anesthetic agents and adjuvants. Replacement of fluids by parenteral administration or by the transfusion of 500 to 1,500 cc. of blood usually is necessary to insure adequate blood pressure levels during the course of the operation. If cardiac arrhythmias appear as a result of vagal stimulation, the anesthetist must report it so that perineural infiltration of procaine hydrochloride may be administered by the surgeon. The addition of 1 or 2 Gm. of procaine hydrochloride to the crystalloid solution given intravenously may prevent arrhythmia. If severe arrhythmia supervenes, the anesthetist may give 50 to 100 mg. of procaine intravenously in a single dose. The compressed lung must be inflated at thirty or forty minute intervals during the operation. Tracheobronchial aspiration is required occasionally during and always after operation to avoid atelectasis. Tension on the diaphragm may be

controlled by the competent administration of curare. Positive intrathoracic pressure must be applied at the conclusion of operation for the dual purposes of complete aeration of the compressed lung and expulsion of the exudate which has accumulated in the thorax during the operation. It is my observation that, with the exception of the surgeon, the anesthetist is the busiest man on the job.

The article on anesthesia by Dr. Harry Brown, which follows this paper, may be consulted for greater detail.

TECHNIC OF OPERATION

The history of the development of the technic of operation has been covered ably by Bird,²⁴ Ochsner and DeBakey¹⁶ and Pack and McNeer.²⁵ It has been pointed out that Sweet and Garlock have contributed greatly to the standardization of technic.

While most writers stress the great advantage which has resulted from the transthoracic approach, I believe that there is another feature which is of equal importance and which has not received the attention in the literature that it deserves. That is the development of the technic of advancement of the stomach or jejunum into the thorax in order to complete esophagogastric or esophagojejunal continuity. In 1904 Mikulicz⁸ operated on 2 dogs in the Sauerbruch positive pressure chamber. In 1 dog he advanced the stomach into the thorax, and in the other he performed transthoracic esophagectomy. At the time of his report the first dog was living and in good health six weeks after operation. The second dog, on the contrary, lived for four weeks and died of inanition from implied stenosis but without evidence of other complication. Cattell,¹⁵ as recently as August 1938, utilized advancement or "reduction" of the stomach into the thorax transperitoneally as a stage preliminary to subsequent successful transthoracic cardioesophagectomy.

By means of the transthoracic and abdominothoracic approaches it now is possible to apply surgical treatment not only to carcinoma limited to the esophagus, cardia and the body of the stomach but also when invasion has extended to adjacent organs. In ideal cases they permit removal of the lesion, adjacent involved organs and regional lymph nodes, with prospects of cure. Essentially the operations consist either of thoracotomy or of abdominothoracotomy, with radical excision of a segment of the esophagus, the cardia, fundus or corpus of the stomach, or even total gastrectomy, with removal of the majority

24. Bird, C. E.: Recent Advances in Surgery of the Esophagus, *Surgery* 6:617-637, 772-801 and 949-975, 1939.

25. Pack, G. T. and McNeer, G.: Surgical Treatment of Cancers of the Gastric Cardia, *Surgery* 23:976-1019, 1948.

of regional lymph nodes, and esophagogastric or esophagojejunal anastomosis within the thorax or even within the base of the neck. Thus, the internal restoration of continuity of the digestive tract which these operations provide offers palliation superior to that of any procedures yet devised.

The technic of operation as utilized in the cases reported here is as follows: In the transthoracic approach the chest is opened between the ribs or, as is usual, through the beds of the seventh, eighth or ninth ribs. In cases of high esophageal lesions the seventh, sixth, fifth and even fourth ribs may have to be divided in order to reach the apex of the thorax. The thoracic cavity first is explored, and any pleural adhesions which may be present are divided with care. Since the advent of curare, it no longer is necessary to avulse, divide or crush the phrenic nerve to overcome resistance of the diaphragm. By its use relaxation of the abdominal muscles also may be secured. The mediastinum is divided posteriorly to the pulmonary ligament, and with blunt finger dissection the distal portion of the esophagus is explored, care being taken to note any apparent involvement of the mediastinal lymph nodes. The distal end of the esophagus then is mobilized over a Penrose drain.

An incision is made through the dome of the diaphragm, and the stomach, regional lymph nodes, liver and peritoneal surfaces are explored manually. At this point, should the lesion prove nonresectable, it only is necessary to close the diaphragm, the mediastinum and the thoracic cage to conclude the operation. If it is decided to proceed with resection, the diaphragmatic incision is extended into the esophageal hiatus, thus creating of the upper abdominal and left thoracic regions a single cavity. If the lesion is situated in the proximal portion of the stomach, resection of that portion of the stomach with the regional nodes is carried out, preferably without removal of the spleen. After the distal portion of the stomach is closed, the esophagus is divided, and an end of the esophagus to side of the stomach anastomosis is completed by the use of three layers of interrupted silk sutures. If the lesion is limited to the esophagus, that organ is freed from its surrounding structures, with due consideration of its blood supply. The stomach then is mobilized and advanced into the thorax to the degree that is required to make a suitable anastomosis either below or above the arch of the aorta. The stomach thus permanently becomes a thoracic organ either partially or wholly. It then is anchored to the mediastinal and parietal pleura, and the diaphragm is closed by suturing it loosely to the stomach walls so as not to produce constriction and thus induce the symptoms which are characteristic of esophageal hiatus hernia.

In case the performance of total gastrectomy is required, it is necessary and simpler to advance a loop of jejunum into the thorax for

esophagojejunal anastomosis. In these circumstances jejunojejunostomy between the proximal and distal loops seems to me to be not only desirable but obligatory.

If the lesion is situated primarily in the corpus of the stomach, with involvement of the cardia, and if there is extension to lymph nodes or other organs below the diaphragm, the combined abdominothoracic incision is extremely valuable. In this procedure an incision through the outer margin of the left rectus abdominus may be made. Through it operability is determined by systematic palpation of the stomach, liver and suprapyloric, supragastric, paracardial, pancreaticolienal, middle colic and infrapyloric lymph nodes. The presence or absence of hepatic nodules or of peritoneal implants under the diaphragm, in the region of the vasa brevia, about the middle colic artery, in the great omentum and in the cul-de-sac thus may be determined. If the tumor appears to be resectable, the incision in the skin is extended upward to the costal arch, where it is extended laterally between the eighth and ninth ribs as far as the medial border of the scapula. The cartilagenous costal arch between these ribs is divided, as are the muscles down to the pleura. Through an initial opening in the pleura a finger is inserted and used as a guide to avoid injury to the lung while the pleural incision is advanced. The diaphragm is incised from its peripheral rib attachment to the esophageal hiatus, with ligation of the phrenic vessels and the small but important vascular branches about the esophageal hiatus. From this point on, the procedure is carried out as described previously, with certain advantages: 1. All manipulations may be carried out under direct vision. 2. The left gastric artery is more easily ligated near its origin from the celiac axis. 3. The lymph nodes in the important area about the celiac axis may be excised more completely. 4. The surgeon may resect involved adjacent organs such as the spleen, the tail of the pancreas or the colon if necessary. 5. Should total gastrectomy be necessary, visualization of the jejunal blood supply is more satisfactory.

Closure of this incision is carried out in the usual manner except that the costal arch must be repaired by approximating the costal cartilages with absorbable or nonabsorbable suture material. The thoracic portion of the wound is closed in layers with interrupted silk. Closure of the abdominal incision is facilitated to a marked degree by first inserting through-and-through sutures of strong material such as steel wire or silk.

POSTOPERATIVE CARE

The postoperative care of patients who have undergone surgical treatment for carcinoma of the esophagus or cardia is extremely impor-

tant. As pointed out by Sweet,²⁶ this is abdominal surgery with thoracic surgical postoperative care.

Before the patient leaves the operating room, the anesthetist should aspirate the tracheobronchial tree. He should ascertain that the blood pressure is at a satisfactory level and that the patient's color is good. If either of these is not satisfactory, intravenous administration of fluids or blood must be continued after the patient has returned to his room and oxygen must be administered intranasally for twenty-four hours or more until the color of the skin improves. Orders are left that the patient is to be turned from side to side at half-hourly intervals and that he is to take six or eight deep inspirations at hourly intervals. The administration of carbogene by mask is exceedingly helpful in securing the patient's cooperation with deep breathing. Coughing should be encouraged to the extent that less rather than more analgesic should be given. If too much analgesic is administered, the respiratory center may be depressed and the patient may not inspire as deeply as he should. On the other hand, if too little is given, he may fail to do so because of pain. There is no instance in which better judgment is required on the part of the nursing personnel than with respect to the administration of analgesics in the early period after operation. Experienced, special nursing is a distinct asset in the conduct of postoperative care in these cases. At present, I prefer to use demerol hydrochloride® in doses of 50 to 100 mg., depending on the weight, age and tolerance of the patient, administered at four to six hour intervals.

Suction on the intrathoracic Foley catheter is maintained for from two to three days, during which time 350 to 500 cc. of serosanguineous fluid usually is removed from the thoracic cavity. When the drainage ceases, the catheter is removed and the stab wound allowed to close spontaneously. In these circumstances it seldom is necessary subsequently to aspirate pleural effusion.

Nutrition is maintained for the first three days by the administration of 1,000 cc. of amigen® and 1,000 cc. of 5 to 10 per cent dextrose in sodium chloride solution. Sips of water are allowed from the outset while constant Levin suction is employed. On the third or fourth day the Levin tube is clamped off for four to six hours while the sips are continued. If they are tolerated by the patient, the Levin tube is removed at the end of the test period. Thereafter thin liquids are given for one day and soft foods for two or three days, after which a general diet is allowed. Ileus usually is minimal and, therefore, seldom is a problem when the thoracic approach is used. There is little gaseous distention or abdominal distress. This is in distinct contrast to what is

26. Sweet,*R. H.: Personal communication to the author.

common experience after laparotomy. Nevertheless, it is the practice to administer neostigmine in dilution of 1:2,000 every six hours for the first seventy-two hours.

Close observation of the chest is mandatory for the first two to five days, during which auscultation should be carried out at six hour intervals. The appearance of pulmonary complications usually is indicated by an abrupt rise in pulse rate, which ordinarily precedes a rise in temperature. If, accompanying these, there are diminished breath sounds in any portion of the chest, beginning atelectasis is assumed. In such circumstances or in case of doubt, tracheobronchial aspiration is carried out with the use of the nasal catheter. This procedure is repeated as often as is necessary until aeration is adequate in all portions of the thorax.

The aid of the anesthetist is solicited during the early postoperative period. The anesthetist should be willing to become a clinician to the extent that he examine the patient's chart, palpate his abdomen and percuss and auscultate the chest. Thus, if the patient has the benefit of the combined attention of the surgeon, his assistant, the anesthetist and the special nurses, there is minimal chance that complications may reach the stage of irreversibility. It is much better to prevent complications than to treat them after they have developed. For this reason it is our practice to endeavor to anticipate complications and employ prophylactic rather than therapeutic measures.

If the functional capacity of the heart allows, the patient usually is assisted to stand at the side of the bed on the afternoon of operation and twice daily thereafter. Walking is encouraged as soon as the patient is able to do so. Usually the patient is able to leave the hospital on the seventh to ninth postoperative day. At home he is encouraged to obtain graduated exercise yet secure adequate rest. The diet may be general. There may be transitory diarrhea owing to section of the vagus nerves, but this seldom requires active treatment. The patient comes to the office on the twelfth to fifteenth postoperative day. Since these patients gain strength somewhat more slowly than others, they are advised to remain away from regular work for eight to twelve weeks.

The follow-up in these cases is extremely important. It is important not only from the standpoint of clinical evaluation of the operation but from the standpoint of the morale of the patient. Most patients experience a period of adjustment if not anxiety, which the surgeon should anticipate and endeavor to minimize by sympathetic attention and counsel. Since most of the patients have various complaints, usually minor in character, it is necessary to see them at four to six week intervals for an indefinite period.

RESECTABILITY

In certain instances and in some types of carcinoma, extension of the tumor to lymph nodes and adjacent organs takes place early. On the other hand, many patients consult the surgeon late. These two factors more than anything else affect the rate of resectability. It appears from the literature, however, that as experience accumulates the rate of resectability is increasing. In accordance with this, my experience has been that the more operations one does, the more cases there are which prove resectable.

MORTALITY

It appears desirable to preface remarks on results of therapy with a statement on mortality. It is important to realize in this discussion that these procedures are employed in the treatment of malignant disease, and the mortality must be considered in that light.

TABLE 1.—*Comparative Mortality in Early and Recent Experience*

Year	Early Experience		Mortality, Per Cent
	Surgeon	Cases	
1871 to 1907	All surgeons.....	All	100.0
1933	Ohsawa ¹³	43	53.4
1940	Garlock ³	19	36.8
1940	Ochsner and DeBakey ¹⁶	4	75.0
1942	Churchill and Sweet ²¹	13	23.0
1943	Phemister (Arch. Surg. 46: 915-929 [June] 1943).. Recent Experience	10	40.0
1948	DeAmestl and Otaiza (Surgery 23: 921-934, 1948)	14	57.0
1948	Thompson (present article).....	16	37.5
1948	Payne and Clagett (Surgery 23: 912-920, 1948)....	33	13.0
1948	Sweet ²⁷	189	0.0 to 23.6

As recently as 1940, 40 per cent of the deaths resulting from cancer in the United States were from cancer of the esophagus and the stomach. Prior to Voelcker's report in 1908, the operative mortality was 100 per cent. It was 1913 when Torek ¹⁰ reported the first successful trans-thoracic resection of the esophagus. Bird ²⁴ found reports of but 17 successful resections prior to 1938. In the early experience with these procedures, regardless of the operator, mortality ranged from 40 to 75 per cent. Likewise, in the early experience of most individual operators, the mortality is high. This was true in my experience.

The comparative mortality in the early and recent experience is given in table 1. This material is not presented as in any way critical of the individual surgeons. On the other hand, as pointed out by Garlock, it is a tribute to the perseverance, diligence and skill of the American surgeon. These figures are based on groups of cases as they are presented by the individual author. Because authors group their

cases differently, results reported are not comparable. Moreover, with the exception of Sweet,²⁷ the mortality presented in this table is for each author's entire group regardless of the varying mortality in his subgroups.

TABLE 2.—*Series of Cases*

Case	Age	Diagnosis	Operation	Results
1	43	Adenocarcinoma of cardia with metastasis	3/15/45; transthoracic exploration	Survived operation; died six months after operation
2	64	Squamous carcinoma of esophagus with metastasis	3/30/45; transpleural exploration	Died the day after operation
3	58	Adenocarcinoma of cardia	10/19/45; transthoracic cardioesophagectomy*	Died third postoperative day of massive collapse of right lung
4	53	Squamous cell carcinoma of mid-esophagus with extension to aorta	1/19/46; transthoracic exploration	Survived operation; referred for roentgen therapy
5	60	Squamous cell carcinoma of esophagus with extension to cardia	2/18/46; transthoracic esophagocardiotomy	Died on twenty-first postoperative day of cardiac and pulmonary complications
6	70	Adenocarcinoma of cardia with extension to esophagus	3/28/46; transthoracic cardioesophagectomy	Died of shock on day of operation
7	47	Adenocarcinoma of cardia with extension to esophagus	7/19/46; transthoracic cardioesophagectomy	Survived operation; died six and one-half months after operation
8	64	Adenocarcinoma of cardia	7/31/46; transthoracic cardioesophagectomy	Died four days after operation of acute pulmonary edema and atelectasis
9	54	Adenocarcinoma of corpus with extension to cardia	3/19/47; transthoracic cardioesophagectomy	Died eleventh postoperative day of subacute pulmonary complications
10	42	Adenocarcinoma of corpus with extension to cardia	5/2/47; transthoracic cardioesophagectomy	Living eighteen months after operation with evidence of generalized carcinomatosis
11	69	Large benign peptic ulcer of esophagus	7/19/47; transthoracic esophagocardiotomy	Living sixteen months postoperatively
12	47	Squamous carcinoma of esophagus with adenocarcinoma of cardia	1/16/48; transthoracic esophagocardiotomy	Died eight months after operation
13	58	Squamous carcinoma of mid-esophagus	2/12/48; transthoracic esophagocardiotomy	Working nine months after operation
14	51	Adenocarcinoma of corpus with extension to cardia	8/13/48; subtotal gastric resection with esophagojejunostomy	Died two months after operation of carcinomatosis
15	57	Leiomyosarcoma of cardia	10/20/48; transthoracic local excision of leiomyosarcoma	Survived operation; dismissed twenty-first postoperative day; returning to outpatient clinic
16	70	Reticulum cell lymphosarcoma of corpus with extension to cardia	11/16/48; abdominothoracic total gastrectomy with esophagojejunostomy	In hospital fourteenth * postoperative day

* Except when specified, continuity was reestablished in all operations by esophagogastrostomy.

A series of 16 personal cases is reported in table 2. In 3 cases exploration only was possible. In 12 cases transthoracic resection was carried out, with reestablishment of continuity by esophagogastrostomy in 10 and by esophagojejunostomy in 2. In 1 case local excision of a leiomyosarcoma was performed. There were five

27. Sweet, R. H.: The Treatment of Carcinoma of the Esophagus and Cardiac End of the Stomach by Surgical Extirpation, Surgery **23**:952-975, 1948.

hospital deaths in the first series of 8 cases and 1 in the last series of 8 cases, or an over-all mortality of 37.5 per cent. One patient died two months, 1 six and one-half months and another eight months after operation. Four are living six weeks to seventeen months after operation. One patient is retired, 1 is working, 1 is ready to return to work and 1 is still in the hospital.

A review of this table indicates three things: (1) world distribution of mortality; (2) mortality according to the individual experience of the operator, and (3) the remarkable progress which has been made in the fifteen years since 1933. To sum up, the table is presented to illustrate how, beginning with a world mortality prior to 1908 of 100 per cent, by 1948 and in certain groups of cases mortality has been reduced to 0.0 per cent.

SUMMARY AND CONCLUSIONS

During the last decade the transthoracic approach in esophageal and gastric surgery has become established. On the basis of work reported during the last few years, it appears that the abdominothoracic approach in certain cases is a valuable addition to this method of attack on lesions which are more extensive below the diaphragm. A brief discussion of the anatomy, pathology and history and of their application to the treatment of carcinoma of the esophagus, cardia, fundus and corpus of the stomach is accompanied with an outline of the clinical and diagnostic features of these conditions. Details of the preparation of the patient, anesthesiologic considerations and postoperative care have been given along with a general discussion of the transthoracic and abdominothoracic approaches and the technic of operation.

NOTE.—The patient in case 16 is living and well four months postoperatively. Since the list in table 2 was submitted, another patient has been operated on. On Dec. 8, 1949, through an abdominothoracic incision, subtotal gastrectomy with partial hepatectomy and esophagogastrostomy were performed for reticulum cell lymphosarcoma. The patient was dismissed from the hospital on the thirteenth postoperative day. Thus, in the series of 17 cases, the mortality is 35.3 per cent.

DISCUSSION

DR. T. G. ORR, Kansas City: Some of these patients can be treated palliatively if you find the condition inoperable on exploration of the chest. I think it is well worth while. I have a patient of that type in whom an anastomosis has been made between the esophagus and the fundus of the stomach and who has been alive several months and has been able to eat rather regularly and is reasonably comfortable. In some of these cases I believe that a palliative operation may be indicated.

DR. HAROLD LINCOLN THOMPSON, Los Angeles: As Dr. Orr was speaking, it occurred to me that it should be pointed out that some of these resections obviously were palliative. One could not perform resection in the patient who lives from three to six months after operation on any other basis. It is believed, however, that the patient who is able to swallow until the last few days or weeks of life has been furnished the best palliation that any procedure yet devised has to offer.

ANESTHESIA IN TRANSTHORACIC SURGERY OF THE ALIMENTARY TRACT

HARRY BROWN, M.D.
LOS ANGELES

THE achievements of transthoracic surgery in a large measure have been made possible by the concurrent advances in anesthesiology. The major problems of anesthesia with relation to the transthoracic approach to the alimentary tract are: (1) maintenance of anesthesia throughout the period of operation; (2) provision of a quiet field for the surgeon when needed; (3) maintenance of adequate oxygenation, with aspiration of the respiratory tract when indicated; (4) maintenance of circulation with proper and adequate fluids; (5) control of vagal reflexes and treatment of cardiac arrhythmias, and (6) inflation of the lungs periodically and at the conclusion of operation. Finally, the anesthetist should work closely with the surgeon in the prevention and treatment of postoperative complications as they pertain to the respiratory tract.

The choice of anesthetic agent or agents is secondary to the ability of the anesthetist to take care of the patient during operation. While it is possible with a tight face mask to maintain anesthesia, intubation of the trachea is preferred. It not only is the best insurance against obstruction of the air passages but it provides an easy means of aspirating the lower bronchi during the operation and at its termination, and it affords greater control over the delivery of oxygen and the anesthetic gases or vapors to the alveoli. While the type of endotracheal catheter is a matter of the anesthetist's individual preference, it is of prime importance to have one large enough, usually, for adults, from 35 F to 40 F. While a tight pharyngeal pack functions well, an inflatable cuff around the endotracheal tube is preferred, to be kept inflated only when the lungs are to be expanded.

Anesthesia in transthoracic surgery demands constant vigilance and foresight, preparation for various contingencies before they arise and, above all, observation of the principle of prevention rather than treatment. Such anesthesia demands an anesthetist with an adequate knowledge of surgical physiology, especially as it pertains to the respiratory, circulatory and nervous systems and the various nervous reflexes. In

Dr. Brown has been an important member of Dr. H. L. Thompson's operating team since early 1946.

addition, he must understand the pharmacologic basis of the agents he wishes to use.

The technic of anesthesia usually is as follows: Prior to operation the surgeon discusses the general problems and the physical status of the patient with the anesthetist. The anesthetist visits the patient before the operation, appraises his physical status and questions him as to his activities with a view to determining the functional capacity of the heart or the limitations of respiratory function. The anesthetist checks the laboratory data, especially the red blood cell and the hemoglobin counts. The anesthetist writes the hospital orders for premedication. In the average case pentobarbital sodium, 3 grains (0.19 Gm.), is given by mouth at bedtime. Phenobarbital sodium, 2 grains (0.13 Gm.), is given intramuscularly two hours preoperatively after the Levin tube is in place. Morphine sulfate, $\frac{1}{6}$ grain (0.01 Gm.), and scopolamine, $\frac{1}{150}$ grain (0.0004 Gm.), are administered one hour preoperatively.

When the patient arrives at the operating room, an intravenous drip of one-sixth molar sodium *r*-lactate is started and anesthesia is induced with pentothal sodium® and *d*-tubocurarine chloride solution.® During the induction period and while the effect of previously administered medicaments is being observed, the patient is given a mixture of 75 per cent nitrous oxide with 25 per cent oxygen. As the curare takes its effect and the respiratory exchange is decreased, the lungs are inflated by manual compression of the breathing bag. This constitutes compensated or assisted respiration given to avoid hypoxia. Thus, after a period of three to five minutes, the patient may be intubated under direct vision laryngoscopy. After this anesthesia is maintained with nitrous oxide and oxygen in a semiclosed system, with frequent manual assistance to respiration after the pleura is opened. Small amounts of pentothal sodium® may be given as indicated. The concentration of oxygen is increased as indicated. Demerol hydrochloride® may be used intravenously if it is apparent that excessive amounts of pentothal sodium® are required.

Every twenty to thirty minutes the progress of the operation is interrupted for one to two minutes while the collapsed lung is expanded by the anesthetist. Prolonged collapse of the lung is undesirable because it produces changes in the pulmonary capillaries as a result of altered blood flow as well as changes in the alveoli themselves. Whenever mucus or other secretion accumulates, it is desirable to aspirate the trachea before inflating the lung.

In all cases a vein is cannulated with an 18 gage needle for administration of blood, crystalloid, pentothal sodium®, procaine hydrochloride or curare. Infusion of compatible blood is started when the cutaneous

incision is made and blood is replaced as rapidly as it is lost. In cases of impaired physical status or low hemoglobin content it is essential to have two veins cannulated so that blood may be pumped in rapidly if needed. To one of the needles I always have a three way stopcock attached. Through one of these, intravenous drip is maintained for administration of the various solutions mentioned. In addition, 5 per cent dextrose in water or sodium chloride solution is used to keep the intravenous needle patent. Each patient receives 500 cc. of sixth molar sodium *r*-lactate preliminary to blood transfusion in order to alkalinize the blood and as prophylaxis against transfusion reaction. Since as a rule shock is synonymous with loss of blood or rough handling of tissues, it is most important to replace blood with blood as it is lost rather than with plasma or with crystalloid solutions. Moreover, it should be replaced at the time it is lost and not afterward. Only by scrupulous attention to many such details can the surgical team expect to maintain the same blood pressure, pulse rate and pulse volume throughout the course of operation.

Apace with the increase in intrathoracic surgery are the number of reports of cardiac arrhythmia and of cardiac standstill. Much remains to be learned about these phenomena. The danger of arrhythmias lies in the progress of certain types to a downward displacement of the pacemaker amounting to ventricular tachycardia followed by ventricular fibrillation, which usually is fatal. The surgeon and the anesthetist must be on a constant watch for cardiac arrhythmia.

In some reported cases it has seemed desirable as prophylaxis to inject into the autonomic nerves at the hilus of the lung 1 per cent procaine hydrochloride either before section of the vagi or immediately arrhythmia is noted. In some instances I have given as prophylaxis an intravenous drip of procaine hydrochloride, 0.1 to 0.5 per cent in dextrose, water or sodium chloride solution. According to reports, the unconscious patient tolerates large doses of intravenously administered procaine hydrochloride without untoward effect and without the appearance of the characteristic symptoms expected on administration of the same dose to the conscious patient. Amounts up to 10 Gm. during an operation of several hours' duration have been reported in the literature to have produced no untoward effect.

If arrhythmia occurs suddenly, one may give procaine hydrochloride, 50 to 100 mg. intravenously, as the most rapid means of administration.

While it is not always necessary for the surgeon to discontinue operation, he should do so if it is indicated. As an alternative he may transfer his activities temporarily to another area of the operative field. If cardiac stoppage occurs, the surgeon should immediately institute manual compression of the heart until spontaneous heart beat is resumed within thirty to sixty seconds. If heart beat is not resumed within this

time, he should inject 1.0 cc. of epinephrine hydrochloride directly into the heart. While the use of epinephrine is viewed as debatable by some, reports indicate that it has promptly restored cardiac activity in patients who otherwise probably would have died. During this trying period, the anesthetist keeps the patient well oxygenated by manual compression of the breathing bag, maintains the blood volume and administers procaine hydrochloride intravenously. A plan of action should be agreed on by the anesthetist and the surgeon before this serious complication is encountered.

It hardly seems necessary to state that it is a part of the anesthetist's duty to keep constantly aware of what the surgeon is endeavoring to do. When the lung projects into the field of operation, the anesthetist can deflate it temporarily and thus greatly facilitate the working conditions of the surgeon. This control of pulmonary activity can be achieved either by controlled respiration technic or by the use of curare to paralyze the respiratory muscles. Properly spaced doses of curare relax the abdominal muscles and prevent the upward pressure of the abdominal contents against the diaphragm, which interferes with the surgeon's work. Judicious use of curare will also weaken diaphragmatic activity without paralyzing it. Efforts directed toward improving the working conditions of the surgeon expedite operation and thus shorten the duration of anesthesia and the surgical procedure.

When the pleura is being closed, the anesthetist inflates the lung. *He should do so just short of bringing the lung to the periphery of the thorax* so as not to interfere with the use of the suture needle. This precaution prevents injury to the visceral pleura.

At the conclusion of operation, the lung is expanded under direct vision. When the wound in the chest is closed and is air tight, the drainage tube from the pleural space is placed under water at a level lower than the patient. During this time the lungs are further inflated while the anesthetist alters the position of the patient by elevating or lowering the head of the operating table and by turning the patient from side to side so as to force all the air out of the pleural space. Finally, the trachea then is aspirated before the endotracheal tube is removed. By careful manipulation of the anesthetic agent, one can have the patient awake or at least in a state wherein the swallowing reflex is active before he is removed from the operation table. This decreases the amount of immediate nursing care required and lessens the likelihood of pulmonary atelectasis.

The anesthetist's participation in the early postoperative care of the patient is as important as it is during operation. During this period the *anesthetist is concerned chiefly with the prevention and treatment of atelectasis*. To this end the patient's chest must be examined every six to eight hours for the first two or three days. While an unexplained

rise in pulse, respiratory rate and temperature and the advent of cyanosis may be significant, these indicators follow rather than antedate the onset of atelectasis. Thus at the time the patient is seen, these indicators may be normal. We place great dependence on suppressed breath sounds over the involved area. The important thing to remember is that the physical signs are not striking in early or minimal atelectasis.

A pulse rate over 100 per minute with slight alteration of breath sounds is sufficient for a presumptive diagnosis of atelectasis in the absence of other causes. As treatment tracheobronchial aspiration is employed under topical anesthesia with pontocaine hydrochloride® in 2 per cent solution. A urethral catheter, size 18 F or 20 F, is passed through the nose into the trachea either blindly or under direct vision. Contact of the catheter with the carina produces violent coughing. Then, by connection of the catheter with the aspirating machine for fifteen to thirty seconds, mucus may be brought up. After the coughing has ceased, oxygen is administered for sixty to ninety seconds, after which aspiration is repeated until all mucus is removed.

In no other type of surgery is teamwork and cooperation between the anesthetist and the surgeon so important. Moreover, the importance of careful observation and prophylactic treatment cannot be overemphasized.

TREATMENT OF JEJUNAL ULCER

A Comparative Follow-Up Study

HENRY K. RANSOM, M.D.

ANN ARBOR, MICH.

RIENHOFF,¹ in discussing the surgical treatment of gastroduodenal ulceration, stated that, regardless of the surgeon or the type of operation performed, when gastric and jejunal mucosa are joined in the presence of acid chyme a certain number of patients will suffer from postoperative complications similar to the original complications of the primary ulcer for which the operation was performed. The truth of this statement has been convincingly demonstrated in appraisals of the remote results of gastroenterostomy, and in fact the frequency of recurrent jejunal ulcer following this operation has been the chief reason for the almost general abandonment of it. Gastric resection, moreover, while yielding results superior to those of gastroenterostomy, is attended by a definite although small percentage of failures due to the development of a secondary ulcer at or near the gastroenteric stoma. The duodenal exclusion operations, in the opinion of most surgeons, are the least satisfactory of all procedures for this same reason.

The incidence of jejunal ulcer following gastroenterostomy has been variously estimated by different authors. In the earlier years, when this procedure was at the height of its popularity, this incidence was estimated by Judd and Hoerner² as 2.8 per cent, by Benedict³ as 2.9 per cent, by Balfour⁴ as 3.26 per cent and by Wilkie⁵ as 3.5 per cent. When the end results are evaluated many years later, it becomes apparent that the actual incidence is considerably higher than these earlier figures would indicate. Thus, in recent years, Ogilvie⁶ esti-

From the Department of Surgery, University of Michigan Medical School.

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1. Rienhoff, W. F.: *An Analysis of the Results of Surgical Treatment of Two Hundred and Sixty-Six Cases of Chronic Peptic Ulcer of the Duodenum*, Ann. Surg. **121**:583, 1945.

2. Judd, E. S., and Hoerner, M. T.: *Jejunal Ulcer*, Ann. Surg. **102**:1003, 1935.

3. Benedict, E. B.: *Jejunal Ulcer: An Analysis of Thirty-Six Cases and Study of the Literature*, Surg., Gynec. & Obst. **56**:807, 1933.

4. Balfour, D. C.: *Results of Gastroenterostomy*, Ann. Surg. **92**:558, 1930.

5. Wilkie, D. P. D.: *Jejunal Ulcer: Some Observations on Its Complications and Their Treatment*, Ann. Surg. **99**:401, 1934.

6. Ogilvie, W. H.: *The Place of Surgery in the Treatment of Peptic Ulcer*, Lancet **1**:419, 1935.

mated the incidence to be about 20 per cent, Lahey⁷ 15 per cent or higher and Wangenstein⁸ 15 per cent. Cooper,⁹ in a critical review of 279 gastroenterostomies performed at the New York Hospital over a thirteen year period, reported an operative mortality of 3.2 per cent and a recurrence rate of 25.2 per cent among the survivors during the first five years. However, he pointed out that reevaluation at the end of the five year period revealed that one quarter of these patients had become relieved by further medical treatment, and the percentage of failures is therefore reduced to 16.3 per cent. He concluded that a patient subjected to gastroenterostomy has a 96.7 per cent chance of surviving the operation and, if he does survive, he has a 78 per cent chance of remaining well thereafter. Even though he should have further trouble, he has an 88 per cent chance of becoming well without further surgical treatment and a 92 per cent chance of being relieved should further surgical intervention be required. In other words, his chances of survival and ultimate cure are about 89 per cent. Gardner and Hart¹⁰ have recently reported on a group of 68 patients carefully selected and treated with gastroenterostomy. There were 5 deaths, or a mortality of 7.3 per cent, and an incidence of recurrence of 5.6 per cent. They stated the belief that gastroenterostomy is a satisfactory operation provided it is restricted to a certain group of patients, i. e., those in the older age groups with relatively inactive ulcers and a high degree of pyloric obstruction.

With regard to gastric resection, Allen and Welch¹¹ reported three jejunal ulcers in 129 primary operations for duodenal ulcers (Finsterer operations excluded), or an incidence of 2.3 per cent. St. John, Harvey, Ferrer and Sengstaken¹² reported 2 cases of verified jejunal ulcer among 373 patients who survived operation and 3 additional cases in which jejunal ulcer may have occurred. The incidence was, therefore, somewhere between 0.5 and 1.4 per cent. Wangenstein reported only 2 instances of soma ulcer in over 500 consecutive resections for ulcer

7. Lahey, F. H.: Inflammatory Lesions of the Stomach and Duodenum, *J. A. M. A.* **127**:1030 (April 21) 1945.

8. Wangenstein, O. H.: The Role of the Surgeon in the Management of Peptic Ulcer, *New England J. Med.* **236**:191, 1947.

9. Cooper, W. A.: End Results in the Treatment of Peptic Ulcer by Posterior Gastroenterostomy, *Surgery* **23**:425, 1948.

10. Gardner, C. E., and Hart, D.: The Surgical Treatment of Peptic Ulcer: A Comparison of the Results of Gastroenterostomy, Gastric Resection and Vagotomy at the Duke Hospital, *Ann. Surg.* **127**:1056, 1948.

11. Allen, A. W., and Welch, C. E.: Subtotal Gastrectomy for Duodenal Ulcer, *Ann. Surg.* **124**:688, 1946.

12. St. John, F. B.; Harvey, H. D.; Ferrer, J. M., and Sengstaken, R. W.: Results Following Subtotal Gastrectomy for Duodenal and Gastric Ulcer, *Ann. Surg.* **128**:3, 1948.

(0.4 per cent). Lahey estimated the incidence of jejunal ulcer to be from 2 to 3 per cent after subtotal gastrectomy. Gardner and Hart reported 123 gastric resections (including Finsterer operations) with an operative mortality of 8.9 per cent. Among the 100 cases which were followed there were 5 recurrences.

In most clinics the results achieved by the duodenal or antral exclusion operations advocated by Devine¹³ and Finsterer¹⁴ have been disappointing. Ogilvie¹⁵ estimated that with exclusion gastrectomy jejunal ulcer may be anticipated in 30 to 40 per cent of cases. In his series of Finsterer resections for exclusion performed in 1937, a jejunal ulcer developed within two years in 9 of 22 patients and in 1 instance a jejunal ulcer perforated in less than three weeks after the patient left the hospital. Lahey stated that with 20 Finsterer operations performed in his clinic a higher incidence of anastomotic ulcer in the stump of the resected stomach was observed than with any other procedure. Allen¹⁶ reported that jejunal ulcer developed in 5 of his 9 cases in which Finsterer resection was done. Three of the patients were reoperated on and cured by antrumectomy and resection of the ulcer area. In contrast with this, he had performed exclusion resections in 20 cases in which the antral mucosa was removed as recommended by Bancroft,¹⁷ with no jejunal ulcers. He further observed 2 patients with jejunal ulcer, originally operated on elsewhere by the Finsterer technic, in whom there was prompt recurrence. Both of these patients were relieved by antral excision only. In an experience with nearly 100 cases in which the antrum was left but the mucosa removed, Wangenstein found no jejunal ulcers. Gardner and Hart stated that in 23 of their cases of resection a duodenal ulcer was excluded by dividing the pyloric antrum 6 to 8 cm. above the pylorus. In 12 cases the antral mucosa was removed, and in 11 it was left intact. There was only one recurrent ulcer in this group of 23 cases, and in this case the pyloric mucosa had been left. They stated the belief that antral exclusion is a useful procedure but now recommend exenteration of the antral mucosa.

As yet it is too early to determine the position that vagotomy will eventually come to occupy in the management of duodenal ulcer. Being

13. Devine, H. B.: *Basic Principles and Supreme Difficulties in Gastric Surgery*, Surg., Gynec. & Obst. **40**:1, 1925.

14. Finsterer, H.: *Ausgedehnte Magenresektion bei Ulcus duodeni statt der einfachen Duodenal-resektion bzw., Pylorusausschaltung*, Zentralbl. f. Chir. **45**: 434, 1918.

15. Ogilvie, H.: *Gastrectomy: A Human Experiment*, Lancet **2**:377, 1947.

16. Allen, A. W.: *The Importance of the Antral Mucosa in the Surgical Treatment of Peptic Ulcer*, South. M. J. **36**:368, 1943.

17. Bancroft, F. W.: *A Modification of the Devine Operation of Pyloric Exclusion for Duodenal Ulcer*, Am. J. Surg. **16**:223, 1932.

frequently combined with gastroenterostomy as it is today, it will, of necessity, require many years before a final evaluation can be made. Certain it is that jejunal ulcer occasionally develops after this dual procedure (Wilkinson¹⁸). A sufficient number of jejunal ulcers have been recorded to indicate that recurrence of this type is a real threat when gastroenterostomy is used in combination with vagotomy.

The present study is concerned with a group of 81 patients treated surgically for postoperative jejunal ulcer at the University Hospital during the past twenty years. Operations performed for gastrojejuno-colic fistula or for a malfunctioning or unnecessary gastroenterostomy opening as well as those for recurrent duodenal ulcer following plastic procedures on the pylorus have been excluded intentionally.

It was hoped to determine, if possible, the factors responsible for the failures of surgical treatment, the time of recurrence in relation to the primary operation and whether such patients might ultimately be made well by further surgical treatment and, if so, which of the available procedures were most likely to succeed. Of the 81 patients, 69, or 85.2 per cent, were men and 12, or 14.8 per cent, were women. The age range was 25 (3 patients) to 75 years, with an average of 48.4 years. The age range for the female patients was 39 to 70 years, with an average of 51.4 years. The average for the male patients was 47.9 years. This group of patients had proved to be unusually refractory to the usual forms of treatment, and already they had undergone a total of 106 previous operations for some type of peptic ulceration. One patient had been subjected to four previous operations, 3 patients to three operations, 16 patients to two operations and the remaining 61 to one operation. A list of these previous operations is given in table 1. It will be noted that gastroenterostomy was the procedure which most often had failed, and this was followed in frequency by the duodenal exclusion operations, while gastric resection, including three pylorectomies, was third in importance. The list is largely self explanatory. In 2 cases a gastric ulcer was excised locally. Subsequently, gastric retention of a degree sufficient to require gastroenterostomy developed in both patients. In 2 patients an initial gastroenterostomy mechanism had already been dismantled and later reestablished. A jejunojejunostomy had been performed without success in 1 case for a jejunal ulcer which had followed gastroenterostomy. The gastrostomy and the subsequent closure were employed in the treatment of an esophageal ulcer producing severe dysphagia in a patient who previously had undergone a gastroenterostomy for a duodenal ulcer. Thirty-two of the 106 original operations were performed

18. Wilkinson, S. A.: The Peptic Ulcer Problem, *J. A. M. A.* **138**:805 (Nov. 13) 1948.

in University Hospital, and the operation directly responsible for the jejunal ulcer was performed elsewhere in 53 instances and at this hospital in 28. These operations are divided into the three aforementioned groups: (1) gastroenterostomy in 57 instances; (2) gastric resection in 9, and (3) antral exclusion operations in 15.

It is commonly believed that antecolic anastomoses, with a long proximal jejunal loop, are especially apt to be followed by recurrence (Lannin¹⁹) and that this is particularly true if an enteroenterostomy is added. In this series only 2 of the gastroenterostomies were of the anterior type, while 55 were of the retrocolic variety, and in no instance

TABLE 1.—*Previous Operations—81 Patients*

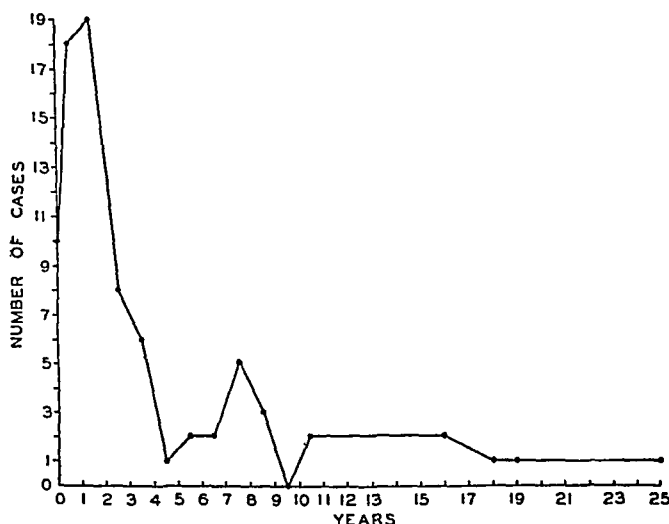
Surgical Procedure	No. of Operations
Gastroenterostomy	60
Devine exclusion.....	8
Gastric resection.....	7
Closure of acute perforation.....	7
Finsterer resection for exclusion.....	6
Pylorectomy	3
Excision of gastric ulcer.....	2
Closure of acute perforation and gastroenterostomy.....	2
Dismantling of gastroenterostomy mechanism.....	2
Gastroenterostomy and excision of duodenal ulcer.....	1
Vagotomy (abdominal).....	1
Plastic to jejunal ulcer.....	1
Jejunojejunostomy	1
Gastrostomy	1
Closure of gastrostomy.....	1
Unknown	3
Total.....	106

had complementary enteroenterostomy been performed. In the group of 9 cases in which gastric resection had failed, small resections which were scarcely more than pylorectomies had been performed in 2, while in the remaining 7 one half or more of the stomach had been removed. In these 7 cases the reconstruction had been made by the posterior Polya method in 3, the anterior Polya method in 1 and the posterior Hofmeister method in 2, all without enteroenterostomy. In 1 case the technic employed originally was not ascertained, as the patient was treated by means of transthoracic vagotomy. In the case of the two pylorectomies, 1 patient had undergone antecolic anastomosis and 1 a posterior Roux Y type of anastomosis, a procedure generally conceded to be conducive to a poor result.

19. Lannin, B. G.: Evaluation of a Satisfactory Operation for Ulcer, Surgery 17:712, 1945.

The exclusion operations consisted of the Devine procedure (simple transection through or above the antrum and reconstruction without the resection of any gastric tissue) in 8 instances and Finsterer's resection for exclusion in 7. In all cases the Devine procedure that had been carried out was posterior anastomosis without enteroenterostomy. Of the Finsterer operations, five had consisted in posterior anastomosis and two in antecolic connection. In 1 case in which the latter was performed a complementary enteroenterostomy had been added. All these exclusion operations, save one Devine procedure, had been performed in this hospital.

The total experience with the exclusion operations may be summarized briefly in the following statements. Follow-up data are available



Interval between responsible operation and recurrence of symptoms.

in 22 cases of primary duodenal ulcer treated by Finsterer's resection for exclusion, 14 similar cases in which the Devine exclusion operation was performed and 29 cases in which the Finsterer procedure modified by exenteration of the antral mucosa was employed. The results in these three groups are: (a) 7 patients are well, 5 are improved and 10 are in poor condition; (b) 2 patients are well, 3 are improved and 9 are in poor condition; (c) 25 patients are well, 1 is improved and 3 are in poor condition.

With regard to the lesion for which the original operations were performed, it is worthy of mention that none of these procedures was for gastric neoplasms, e. g., carcinoma, leiomyoma, neurofibroma, lymphosarcoma or polyposis. In 7 cases the lesion was a gastric ulcer, and in the remainder the evidence is either positive or presumptive that the ulcer was distal to the pylorus.

The accompanying graph presents data concerning the interval between the responsible operation and the onset of symptoms of recurrence. It is somewhat surprising to note that in 10 cases recurrent symptoms appeared almost immediately, i. e., before or shortly after the patient left the hospital. In 18 additional cases recurrence took place in less than one year, and in 19 others it had manifested itself in less than two years. Thus, in 34.6 per cent of the patients recurrence had taken place in less than one year, in 58.6 per cent in less than two years and in 76.5 per cent within five years. While in most cases the recurrence was observed by the end of five years, it will be observed that in 2 it was observed at sixteen years, in 1 at eighteen, in 1 at nineteen years and in 1 at twenty-five years.

The indications for further surgical intervention in these cases of jejunal ulcer were chiefly pain and hemorrhage, either singly or in combination. Forty-three patients had predominantly symptoms of ulcer pain, 25 pain and hemorrhage and 7 bleeding without other significant symptoms. Two patients in this last group exhibited severe anemia due to loss of blood. Five patients were found to have considerable gastric retention due to duodenal stenosis consequent on the original ulcer and subsequent closure of the gastroenteric stoma by the jejunal ulcer. In 1 case a jejunal ulcer which had followed a posterior gastroenterostomy underwent acute perforation. All patients for whom a diagnosis of jejunal ulcer was made have not been treated surgically, and some have remained reasonably well on a strict medical regimen. However, the ever present danger of the development of a gastro-jejunocolic fistula makes one apprehensive of long delay if evidence of improvement is not soon demonstrable.

TREATMENT

When dealing with jejunal ulcer, the operation chosen is governed considerably by the previous operative procedure, the condition of the patient, the technical difficulties presented and, in part, the preference of the surgeon. In the discussion of this phase of the problem the grouping used previously has been followed.

JEJUNAL ULCER FOLLOWING GASTROENTEROSTOMY

Cases of jejunal ulcer following gastroenterostomy constituted the largest group, numbering 57 (table 2). Considered from a historical viewpoint, the favored procedures have been: (1) dismantling of the gastroenterostomy mechanism, with or without a plastic procedure on the pylorus; (2) some form of gastric resection, and (3) vagotomy.

Dismantling of Gastroenterostomy Mechanism.—When gastroenterostomy has failed it was believed formerly that restoration of the

gastrointestinal tract to normal afforded the safest and best solution. Inasmuch as the original ulcer had usually healed at this time, symptoms often could be controlled reasonably well by restoration of the tract to normal and elimination of the anastomotic ulcer, to be followed by a careful medical regimen. In certain cases in which an original gastroenterostomy had been performed without adequate indication this was especially true. If narrowing of the pyloric orifice due to scar was found to persist, enlargement could be readily effected by an associated pyloroplasty. Simple dismantling of the gastroenterostomy mechanism was performed in 10 cases in this series, with 2 operative deaths, 1 due to peritonitis (autopsy) and 1 due to intestinal obstruction (no autopsy). Disconnection of the anastomosis, with a complementary pyloroplasty, was carried out in 8 cases, with no deaths. These procedures are simpler and safer than those involving some form of gastric resection

TABLE 2.—*Treatment of Jejunal Ulcer Following Gastroenterostomy—57 Cases*

Operation	No. of Cases
Gastric resection.....	32
Dismantling of gastroenterostomy mechanism (2 deaths).....	10
Dismantling of gastroenterostomy mechanism and pyloroplasty.....	8
Finsterer exclusion.....	3
Finsterer-Baneroft exclusion.....	1
Excision of ulcer with Reanastomosis.....	1
Gastric resection and abdominal vagotomy.....	1
Jejunostomy	1

and avoid the danger of the formation of a new stomal ulcer, although the possibility of recrudescence of the original ulcer or the formation of a new one in the stomach or duodenum remains.

Gastric Resection.—With the available evidence indicating the effectiveness of partial or subtotal gastrectomy in the treatment of primary gastric or duodenal ulcer, logically it should promise superior results in the treatment of jejunal ulcer. Subtotal resection as a secondary operation at times entails considerable risk, and the technical difficulties associated with the removal of a large inflammatory mass at the stoma may necessitate the selection of some other procedure. Standard resection with appropriate management of the involved jejunal segment was employed in 32 cases, and Finsterer's resection for exclusion was used in 3. In these 3 cases the pyloric antrum was left intact, whereas in an additional case a Finsterer operation was performed and the antral mucosa removed.

Local Excision.—In 1 case the jejunal ulcer was excised locally and the original anastomosis reconstructed.

Jejunostomy.—In 1 debilitated patient with severe bleeding from a jejunal ulcer and a large inflammatory mass at the stoma a jejunostomy for feeding was employed, with the hope that as a result of physiologic rest subsidence would take place.

Vagotomy.—In this group solitary vagotomy as the first operative procedure for jejunal ulcer was not performed. In 1 case subdiaphragmatic section of the vagus nerve was employed in addition to gastric resection.

JEJUNAL ULCER FOLLOWING GASTRIC RESECTION

When a classic type of resection, including removal of the antrum, had already been performed, the several procedures consisted of reresection of the stomach, local excision of the ulcer and vagotomy (table 3).

Reresection.—When an original resection has failed, resection higher up would seem likely to succeed in view of the clinical and experimental evidence presented by Wangenstein, who stated the belief that a three-quarter resection, with a short afferent loop, is essential for a

TABLE 3.—*Treatment of Jejunal Ulcer Following Gastric Resection—9 Cases*

Operation	No. of Cases
Reresection (1 death).....	7
Excision of ulcer with reconstruction of anastomosis.....	1
Transthoracic vagotomy.....	1

satisfactory result. Since many of the original resections had been of less magnitude than this, the performance of a large or adequate resection was undertaken in 7 cases. There was 1 death in this group due to postoperative hemorrhage (no autopsy).

Local Excision.—In 1 case a simple excision of the anastomotic ulcer, with repair of the old anastomosis, was performed.

Vagotomy.—In 1 case a transthoracic vagotomy was elected.

JEJUNAL ULCER FOLLOWING EXCLUSION OPERATIONS

In the group of cases of jejunal ulcer following exclusion operations, because of the anatomic features and the physiologic principles involved, several procedures may be considered. These are (1) reresection with excision of the antrum; (2) reresection without antral excision; (3) antral excision only, and (4) vagotomy (table 4).

Reresection with Antral Excision.—Although the most comprehensive and not always technically feasible, this would seem to be the preferable procedure. It was employed in 6 cases, with no deaths.

Reresection Without Antral Excision.—In view of the accumulated evidence regarding the danger attendant on a retained pyloric antrum,

this procedure might be expected to invite recurrence. It was utilized in 4 cases, with 1 death, probably due to peritonitis (no autopsy).

Antral Excision Only.—The interesting observation has been made by McKittrick,²⁰ Marshall,²¹ Allen, Lahey and others that jejunal ulcers may undergo prompt healing after the removal of a retained antrum. In this series antral excision only was employed in 3 cases, with 1 death, which was the result of pancreatitis and peritonitis (autopsy) presumably due to injury to the pancreas during the dissection in a field of dense adhesions. The closed duodenal stump was found to be intact when examined at autopsy.

Vagotomy.—In the extensive literature now available concerning vagotomy, the results reported from its use in the treatment of recurrent ulcer following resection are remarkable. Dragstedt²² has reported cure by vagotomy in a case of recurrence following a Finsterer exclusion procedure even though the antrum remained. Moore,²³ however, observed that transthoracic vagotomy alone failed to cure but that when

TABLE 4.—*Treatment of Jejunal Ulcer Following Exclusion Operations—15 Cases*

Operation	No. of Cases
Reresection with antral excision.....	6
Reresection without antral excision (1 death).....	4
Antral excision only (1 death).....	3
Antral excision and transthoracic vagotomy (two stage).....	1
Jejunostomy (1 death).....	1

the antrum was eliminated recovery promptly took place. The experience of my colleagues and me in this field is limited to 1 case in which a combined procedure was used. Antral excision was performed as a first stage and was followed three weeks later by a transthoracic vagotomy.

Jejunostomy.—In 1 case, because of almost complete obstruction at the stoma due to a recurrent ulcer in a patient who originally had undergone a Finsterer operation, jejunostomy only was performed.

In table 5 the operative deaths are summarized. There were 6 deaths among the 81 operations, or an over-all mortality of 7.4 per cent.

20. McKittrick, L. S.; Moore, F. D., and Warren, R.: Complications and Mortality in Subtotal Gastrectomy for Duodenal Ulcer: Report on Two Stage Procedure, *Ann. Surg.* **120**:531, 1944.

21. Marshall, S. F., cited by McKittrick, Moore and Warren.²⁰

22. Dragstedt, L. R.; Harper, P. V.; Tovee, E. B., and Woodward, E. R.: Section of the Vagus Nerves to the Stomach in the Treatment of Peptic Ulcer: Complications and End Results After Four Years, *Ann. Surg.* **126**:687, 1947.

23. Moore, F. D.: Vagus Resection for Ulcer: An Interim Evaluation; II. Clinical Results, *Ann. Surg.* **126**:664, 1947.

It is noteworthy that a number of the deaths occurred after the simpler procedures. This probably is to be explained by the fact that such procedures were usually chosen for the poor risk patients and that many of these operations were performed during the earlier years when the preoperative and postoperative management of fluid and electrolyte balance was poorly understood and before the advent of chemotherapeutic and antibiotic agents and the institution of blood banks.

FOLLOW-UP STUDIES

Seventy-five patients survived operation and have been followed to the time of their death, from whatever cause, or until the completion of this report. Table 6 gives the duration of the follow-up study in five

TABLE 5.—*Operative Deaths (6; Mortality, 7.4 Per Cent)*

Operation	Cause of Death	Autopsy
Dismantling of gastroenterostomy mechanism.....	Peritonitis (leak at closure of stomach)	+
Dismantling of gastroenterostomy mechanism.....	Intestinal obstruction	—
Reresection	Hemorrhage	—
Reresection	Peritonitis (?)	—
Antral excision.....	Pancreatitis and peritonitis	+
Jejunostomy	Inanition	—

TABLE 6.—*Duration of Follow-Up Study—75 Cases*

Number of Years After Operation	Living	Dead
5 or less.....	25	15
5 to 10.....	19	5
10 to 15.....	4	2
15 to 20.....	1	1
Over 20.....	3	..
Total.....	52	23

year periods. The 52 patients still living have been followed for from one to twenty-three years. In the case of the 23 patients who have died since their discharge from the hospital, data regarding the cause of death are found in table 7. While the usual causes of death in persons of this age, e. g., coronary thrombosis, pneumonia and hypertension, are in evidence, it is disturbing to find that 14 patients, or 61 per cent, died of further recurrence. Nine of these deaths were due to a new recurrent ulcer and for the most part were accounted for by the complications of hemorrhage and perforation. The remaining 5 patients died after secondary operations for recurrent or jejunal ulcer. Further details of this group are given later.

In the final evaluation of results, each patient was classified on the basis of all the data collected over the years. So far as possible the results listed are in terms of symptoms of ulcer, complications and related disability. Other factors, such as associated diseases or senility, are excluded. The term "well" indicates that the patient is free from symptoms of ulcer, e. g., pain, nausea and vomiting or a history of bleeding, and that he is on an unrestricted or a slightly restricted diet. "Improved" indicates that there are some minor residual symptoms, e. g., pain or discomfort at times, especially after dietary indiscretions. Such symptoms are not incapacitating and are controlled with a reasonable amount of care. In this group there is no roentgenologic or gastroscopic evidence of recurrence. A "poor" result indicates that the patient remains unimproved or has become worse. Patients with poor results have uniformly shown evidence of recurrence, either in the form

TABLE 7.—*Cause of Death in 23 Patients Who Have Died Since Discharge*

Cause of Death	No. of Cases
Recurrent ulcer.....	9
Reoperation for recurrence.....	5
Coronary thrombosis.....	3
Pneumonia	2
Hypertension and myocarditis.....	2
Cerebral hemorrhage.....	1
Accident	1

of a new recurrent jejunal ulcer after resection or exclusion operations or as a new gastric or duodenal ulcer or the reactivation of an old one when the gastrointestinal tract was restored to normal. None of the results listed as poor has been due to complications of the operation, such as injury to the bile ducts, intestinal obstruction, fistula or ventral hernia, or to side effects such as the dumping stomach or serious post-resection symptoms.

JEJUNAL ULCER FOLLOWING GASTROENTEROSTOMY

In table 8 data are presented concerning the results of the several operations for ulcers following gastroenterostomy (55 cases). As might be anticipated, gastric resection gave the best results, since 24 of the 32 patients treated by this method were entirely well and symptom free. One patient was improved, whereas in 7 the results were poor, in 3 instances sufficiently to require further surgical treatment. All patients who required additional surgical treatment are considered in detail in following paragraphs. In 8 cases in which simple closure of a gastroenterostomy opening was performed, 3 patients became well and 1 was improved, while in 4 the results were poor. Two of these

4 patients required further surgical treatment. Closure of the gastroenterostomy opening combined with pyloroplasty resulted in a smaller number of patients who became well (only 1), a higher incidence of those who were improved (6) and only 1 poor result. The patient who had this result required further surgical therapy.

Contrary to our expectations, the Finsterer exclusion operations resulted in failure in only 1 instance, the patient requiring further surgical treatment, while the 2 remaining patients became symptom free. The results in the case in which Bancroft's modification of the Finsterer procedure was employed was entirely satisfactory. Local excision of the ulcer with reestablishment of the original gastroenterostomy opening

TABLE 8.—*Results of Treatment of Ulcers Following Gastroenterostomy—55 Cases*

Type of Operation	Result	No. of Cases
Gastric resection.....	Well	24
	Improved	1
	Poor	7 (additional surgical treatment — 3)
Dismantling of gastroenterostomy mechanism.....	Well	3
	Improved	1
	Poor	4 (additional surgical treatment — 2)
Dismantling of gastroenterostomy mechanism and pyloroplasty	Well	1
	Improved	6
	Poor	1 (additional surgical treatment — 1)
Finsterer exclusion operation.....	Well	2
	Poor	1 (additional surgical treatment — 1)
Finsterer-Bancroft exclusion operation.....	Well	1
Excision of ulcer with reanastomosis.....	Poor	1
Gastric resection and abdominal vagotomy.....	Well	1
Jejunostomy	Poor	1

gave a poor result since symptoms promptly returned. The patient treated with a combined classic resection and abdominal vagotomy obtained an excellent result. The palliative jejunostomy is recorded as a failure, as the patient died four months after operation of massive hemorrhage from the unhealed ulcer.

JEJUNAL ULCER FOLLOWING RESECTION

In the small group of 8 cases in which a primary gastric resection had failed, further resection of the stomach afforded an excellent result in 4 cases and a poor result in 1, while 1 patient was improved. As in the gastroenterostomy group, the local excision of a stomal ulcer with reestablishment of the same anastomosis resulted in failure. The one example of a solitary transthoracic vagotomy was followed by an excellent result (table 9).

JEJUNAL ULCER FOLLOWING EXCLUSION OPERATIONS

In the group of 12 cases of ulcer following exclusion operations, the procedure of greatest magnitude, i. e., reresection and excision of the antral segment, was employed in 6 cases, and all the patients were restored to excellent health. Further resection of the stomach not accompanied with removal of the antrum was, on the whole, unsuccessful, since only 1 patient among 3 became well, 1 was improved and in 1 the result was so poor that further surgical treatment was necessary. In our experience treatment of anastomotic ulcers following exclusion

TABLE 9.—*Results of Treatment of Ulcers Following Gastric Resection—8 Cases*

Type of Operation	Result	No. of Cases
Reresection	Well	4
	Improved	1
	Poor	1
Excision of ulcer with reanastomosis.....	Poor	1
Transthoracic vagotomy.....	Well	1

TABLE 10.—*Results of Treatment of Ulcers Following Exclusion Operations—12 Cases*

Type of Operation	Result	No. of Cases
Reresection with antral excision.....	Well	6
Reresection without antral excision.....	Well	1
	Improved	1
	Poor	1 (additional surgical treatment — 1)
Antral excision and transthoracic vagotomy.....	Well	1
Antral excision only.....	Poor	2 (additional surgical treatment — 2)

operations by removal of the antrum alone has not been followed by satisfactory results, since, as previously mentioned, 1 patient died after the operation, while the 2 who survived had poor results. Both required additional operations, and after these both succumbed. The patient treated with a combination of antral excision and transthoracic vagotomy was completely relieved (table 10).

ADDITIONAL SURGICAL TREATMENT

Ten patients who obtained poor results from the first operation for jejunal ulcer in our hospital required further surgical treatment from us or elsewhere. The cases are summarized in table 11. The operations for jejunal ulcer which had failed in the 10 cases were: (a) closure of gastroenterostomy opening in 2 cases; (b) closure with pyloroplasty in 1 case; (c) antral excision in 2 cases; (d) Finsterer exclusion in 1 case; (e) subtotal gastrectomy in 3 cases, and (f) reresection in

1 case. Six of the 10 patients underwent one additional operation, and 4 required two additional procedures. Seven patients subsequently died, 3 of them after these secondary operations and 3 because of a continuation of their disease. The result in 1 case is unclassified, as

TABLE 11.—Cases in Which Additional Surgical Treatment Was Required

Patient, Sex, Age	Course	Final Result
B. I. Male 58	Duodenal ulcer, posterior gastroenterostomy..... 1914 Dismantling of gastroenterostomy mechanism..... 7/11/35 Anterior gastroenterostomy..... 8/ 7/36 Died after recurrence..... 9/16/36	Poor
W. B. Male 54	Duodenal ulcer, posterior gastroenterostomy..... 1931 Dismantling of gastroenterostomy mechanism..... 5/16/47 Subtotal gastrectomy..... 4/27/48 Well, with minor side effects..... 11/ 6/48	Well
J. J. Male 28	Duodenal ulcer, posterior gastroenterostomy..... 10/ 7/24 Dismantling of gastroenterostomy mechanism, with pyloroplasty 10/14/26 Posterior gastroenterostomy (elsewhere)..... 1945 Transthoracic vagotomy..... 8/ 8/46 Improved—hypertrophic gastritis..... 6/ 1/48	Improved
F. B. Female 39	Duodenal ulcer, Finsterer exclusion *..... 11/29/41 Antral excision..... 1/ 7/42 Total gastrectomy..... 6/24/42 Died from peritonitis..... 6/27/42	Poor
F. Y. Male 62	Gastric ulcer, Finsterer exclusion *..... 4/ 1/43 Antral excision..... 5/19/44 Transverse colostomy for gastrojejunoecolic fistula 4/25/45 Died from perforation and peritonitis..... 6/23/45	Poor
F. S. Male 69	Duodenal ulcer, posterior gastroenterostomy..... 1928 Finsterer exclusion 2/19/38 Reresection without antrumectomy..... 4/17/41 Reresection with antrumectomy..... 4/ 3/42 Died from pancreatic fat necrosis and peritonitis... 4/23/42	Poor
A. B. Male 42	Gastric ulcer, Finsterer exclusion *..... 8/ 3/27 Reresection without antrumectomy..... 9/26/28 Closure, acute perforation of jejunal ulcer (elsewhere) 1937 Exclusion of jejunal ulcer..... 8/12/38 Died from cerebral hemorrhage..... 1/ 5/39	Poor (?)
F. B. Male 25	Duodenal ulcer, posterior gastroenterostomy *..... 7/23/27 Subtotal gastrectomy..... 1/20/30 Dismantling of posterior gastroenterostomy mechanism and establishment of anterior gastroenterostomy opening for gastrojejunoecolic fistula (elsewhere) 2/17/41 Died 2/23/41	Poor
G. R. Male 41	Duodenal ulcer, posterior gastroenterostomy..... 10/10/29 Subtotal gastrectomy..... 1/11/39 Repair of gastrojejunoecolic fistula (elsewhere)..... 2/22/47 Anterior gastroenterostomy and vagotomy (elsewhere) 10/23/47 Well 6/14/48	Well
T. L. Male 53	Duodenal ulcer, posterior gastroenterostomy..... 1936 Subtotal gastrectomy..... 11/10/44 Ileosigmoidostomy for gastrojejunoecolic fistula.... 5/ 4/46 Died from inanition and sepsis..... 6/ 5/46	Poor

* The original operation was performed in University Hospital.

death from cerebral hemorrhage occurred five months after the last operation, the patient having remained free during that brief period. Of the 3 living patients, 2 have recently become well, 1 is improved. Cure was accomplished in 1 patient, now free, by subtotal gastrectomy after anastomosis of the enteroc

ing had failed and in the other by vagotomy after subtotal gastrectomy had failed. The patient listed as improved was partially relieved by transthoracic vagotomy after three previous operations for ulcer had been unsuccessful. It is believed that his residual symptoms are due to a persistent hypertrophic gastritis, which is demonstrated both by roentgenograms and by gastroscopy.

The 2 patients who were unrelieved by antral excision deserve special comment. In 1 case a Finsterer exclusion operation was performed as the first stage of a classic resection as advocated by McKitt-rick. A jejunal ulcer developed before the second stage could be undertaken. This was uninfluenced by the antral excision, and five months later the remaining gastric pouch was completely removed. Death occurred because of peritonitis consequent on leakage at the esophagojejunal anastomosis. Microscopic examination of the specimen revealed a large ulcer in the jejunum, with associated carcinoma. Autopsy disclosed a solitary metastasis in the thyroid gland. This case is unique in our experience. The second patient underwent what was considered to be an adequate resection for a gastric ulcer of the lesser curvature, although at that time the surgeon was not certain of the exact level of the lower transection in relation to the pylorus. Symptoms recurred shortly thereafter, and a jejunal ulcer was demonstrated by roentgenologic study. The gastric acidity remained high, and accordingly resection of the upper portion of the duodenum was performed, with the hope of eradicating any remaining antral mucosa. Microscopically, antral tissue was identified. The patient was not relieved by this procedure, a gastrojejuno-colic fistula developed and, in spite of a proximal colostomy, death occurred from perforation and peritonitis.

Gastrojejuno-colic fistulas subsequently developed in 3 other patients, all following gastric resection for jejunal ulcer. Two of the patients died, 1 after an ileosigmoidostomy and 1 after direct repair. The third patient is now well, after a reparative operation for the fistula and a gastroenterostomy with vagotomy eight months later.

COMMENT

The prevention of jejunal ulcer consists first in the proper selection of patients with primary gastroduodenal ulcer for surgical treatment and second in the selection of the operative procedure best suited to the individual case. In this clinic gastrojejuno-stomy has become practically obsolete during the past decade, although recently it has been temporarily revived as an adjunct in certain cases of vagotomy. Vagotomy, either alone or in conjunction with other surgical procedures, has been employed in 64 cases of gastroduodenal ulcer, with the following results: good in 41 (64.1 per cent), fair in 17 (26.5 per cent) and poor in 6

(9.4 per cent). A detailed report of these cases is to be made by Fuller.²⁴ The employment of vagotomy has been temporarily discontinued until a more thorough evaluation of the results in these cases is made. Subtotal gastrectomy remains the standard procedure for both gastric and duodenal ulcer, since in our hands it has given eminently satisfactory results, with a low operative mortality. When the classic operation is attended by difficulty in the management of the duodenal stump, Bancroft's modification of the Finsterer procedure is usually preferred.

In the definitive treatment of gastrojejunal ulcer following gastroenterostomy, the dismantling operations, with restoration of the gastrointestinal tract to normal, have proved unsatisfactory, and there would now seem to be few if any indications for their use. An adequate gastric resection, on the other hand, probably offers the greatest chance of cure. When recurrence follows a conventional or an exclusion gastrectomy, the status of the original resection should be carefully evaluated. If the antrum remains or if the resection was small, a resection that is adequate as judged by present day standards is indicated. When recurrence is encountered in patients who already have been subjected to an acceptable resection, vagotomy affords a new and promising mode of treatment, whereas formerly for this group of patients only total or nearly complete gastrectomy remained.

24. Fuller, W. J.: Personal communication to the author.

DISCUSSION

DR. R. L. SANDERS, Memphis, Tenn.: The subject of vagal resection in the treatment of duodenal and gastrojejunal ulcer is one in which I have been deeply interested since I performed my first operation of this type more than three years ago. Our series now comprises about 150 cases. Eight of the vagal resections have been performed for gastrojejunal ulcer, six of the eight more than a year ago. Six of the patients underwent vagal resection alone, while 2 were subjected to gastric resection as well. To the present time, all these patients have had a good or excellent result. In the 2 who required resection of the stomach there was obstruction both at the pylorus and at the stoma. It has been our observation that if obstruction is appreciable, the combined gastrectomy and vagal resection is advisable; if the stomach empties well, however, resection of the nerves alone is sufficient.

Being abdominal surgeons, we have employed the abdominal approach in all our vagal resections. We believe that this approach is preferable to the transthoracic, chiefly because of the fact that one is thus able to visualize the disease process, but also because the patients are more likely to have a comfortable post-operative course. So far as we have been able to determine, the symptomatic and clinical results are as good as those obtained after the use of the transthoracic approach.

REPEATED MASSIVE INTESTINAL HEMORRHAGE FROM MULTIPLE MALIGNANT TUMORS OF THE JEJUNUM

ORVILLE R. CLARK, M.D.

AND

WILLIAM M. MILLS, M.D.

TOPEKA, KAN.

THE FOLLOWING case seemed to us to demonstrate some difficulties in making a clinical diagnosis of tumors of the small intestine and exhibited several unusual features of sufficient interest to justify reporting it.

REPORT OF A CASE

The patient was a white married man, 58 years of age. His family history and past history were noncontributory. He was admitted to the hospital on March 31, 1948, to the medical service of Dr. Don C. Wakeman, with a history of tarry stools for one month and weakness and dizziness on exertion for two weeks. Two days before his admission he had fainted after taking a few steps.

Examination demonstrated no significant findings except pallor. His hemoglobin content was 40 per cent, with 2,490,000 erythrocytes. Other laboratory studies revealed nothing abnormal except that a stool specimen contained blood. The provisional diagnosis was bleeding duodenal or gastric ulcer.

He was treated by ordinary conservative measures, including transfusions. A few days after admission roentgenologic study of the gastrointestinal tract demonstrated a small hiatus hernia with a congenitally short esophagus, but no ulcer or tumor was visualized.

As the tarry stools continued, the idea of an ulceration due to the hiatus hernia was seriously considered, and phrenicectomy was performed on the left side on April 10, with the hope that paralysis of the left side of the diaphragm might relieve pressure on an ulcerated area if it was due to the hernia. There was a temporary cessation of active bleeding, but on April 28 he passed another large tarry stool, with others on following days, and his hemoglobin content decreased to 34 per cent (with 2,269,000 erythrocytes). At this time it seemed that the stomach might not be the source of the hemorrhage after all, since no definite ulceration could be demonstrated, there had been no permanent improvement after the phrenicectomy and the blood had been passed by rectum but never vomited. Exploratory laparotomy was advised, with the provisional diagnosis of a small intestinal lesion as the source of the bleeding.

After preparation, the abdomen was explored on May 9. The lower part of the small intestine and the colon were found filled with blood, but there was none in the upper part of the jejunum. A polypoid lesion 1 cm. in diameter was felt through the wall of the upper region of the jejunum, attached near the mesenteric

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side. The serosa over the lesion showed hemorrhagic stippling. There was no evident involvement of either regional lymph nodes or liver, and no other lesions of the intestinal tract were noted. A segment of jejunum, including the tumor, was resected and the continuity restored by end to end anastomosis.

The postoperative course was unexpectedly smooth, and the patient was dismissed from the hospital on the tenth postoperative day, with his hemoglobin content rising although he had not been given any additional transfusions postoperatively.

Grossly, the lesion was a spherical tumor about 1 cm. in diameter protruding into the lumen of the bowel, apparently located in the submucous layer and attached at the mesenteric border. On the apex of the growth there was an ulcerated area. The microscopic report was "carcinomatous polyp of the small intestine."

The patient made excellent progress for six weeks after his dismissal from the hospital, when he again began to feel badly and to pass large tarry stools. He was readmitted on July 17, and again the only significant finding on examination was extreme pallor. His hemoglobin content on this occasion was 37 per cent, with 2,030,000 erythrocytes.

With symptoms the same as on his previous admission, the possibility of a similar lesion in another part of the intestinal tract was, of course, immediately suggested. In order to eliminate the stomach as a source of the bleeding, aspiration was carried out with an indwelling Levin tube continuously over a period of nearly twenty-four hours at a time when the patient seemingly continued to bleed. No blood, however, was returned from the stomach during any of this time. The prothrombin content of the blood, the bleeding time, the coagulation time and the clot retraction were all normal. With a presumptive diagnosis of another bleeding lesion of the small intestine, he was prepared for operation without further study.

At operation on July 23, a second tumor—identical in gross appearance to the one removed ten weeks previously—was found on the mesenteric side of the jejunum less than 1 inch (2.5 cm.) below the duodenojejunal junction and some 24 to 30 inches (61 to 76 cm.) above the original anastomosis. A careful search throughout the length of the intestinal tract revealed no other lesions. There was no evidence of any metastatic spread, and the site of the previous anastomosis was in good condition. After consideration of the technical difficulties in resecting the intestine at the level involved, the tumor was removed through an incision on the opposite side of the intestine and the opening closed transversely.

The patient again made a good recovery and was dismissed from the hospital on his fourteenth postoperative day, with a hemoglobin level of 81 per cent and an erythrocyte count of 4,330,000.

The microscopic appearance of the two tumors was identical.

Microscopic slides of this tumor, together with clinical abstracts, were submitted to four consultant pathologists in addition to the two who studied the lesion primarily. The variety of opinions expressed demonstrates the doubtful nature of the tumor.

As noted previously, the original diagnosis of the local pathologists was "carcinomatous polyp." The same diagnosis was originally made for the second tumor, but later, after further study, this was changed to "carcinoid."

One of the consultant pathologists likewise made the diagnosis of "carcinoid," with the following comments: "In my opinion, the type of tumor with which you are dealing in this patient is that which has been called carcinoid, the exact nature of which is not known. When carcinoids appear in the appendix, they are

usually benign. However, it has been my experience that when they are seen in the small intestine they are almost universally malignant. This one which you have, I think, is of a malignant type. Rarely they are multiple when seen in the small bowel, and I think you are dealing with multiple lesions rather than with metastasis or implantations."

The second opinion was that "leiomyosarcoma" was present, with comments as follows: "The structure is obviously that of a smooth muscle tumor, and the nuclei show changes that are characteristic of malignant growth. Mitoses are infrequent, but the bizarre appearance, the extreme variation in size and the presence of multiple nuclei point to a relatively malignant tumor. My diagnosis is leiomyosarcoma."

A third diagnosis was "anaplastic metastatic tumor to small intestine," and the consultant commented: "From the microscopic picture it is evident that this represents a highly anaplastic malignant type of tumor. On the basis of the suggestive location within lymphoid tissue, the presence of two lesions at the site of mesenteric attachment and the greater frequency of metastatic tumors in relation to primary tumors of the small intestine, it seems highly probable that this represents a metastatic lesion, even though the history and the physical condition of the patient do not at present substantiate this diagnosis. On the basis of the material submitted it is my opinion that this is most probably a metastatic malignant melanoma of the amelanotic variety. The small intestine is the not infrequent site of metastasis from this type of tumor, even in the absence of any obvious or recognized primary site for the tumor. A second possibility is that this might represent a metastatic leiomyosarcoma."

This same consultant also showed the slides to three of his friends, one of whom agreed with him; the other two placed metastatic leiomyosarcoma as first choice, with metastatic melanoma as a second choice.

The fourth consultant's diagnosis was "metastatic carcinoma, melanoma to be ruled out," and his comments were as follows: "There are several possibilities which should be considered in multiple malignant tumors of the small bowel. Carcinoids are often multiple, usually occur near the ileocecal valve, have a yellowish appearance grossly and microscopically show a characteristic picture. Invariably carcinoids have rather small cells with small nuclei, and mitotic activity is minimal. I do not believe that this could be a carcinoid; they practically never give rise to gross hemorrhage. Leiomyosarcomas can give rise to massive hemorrhage, but when they do they are usually large. They also have spindle-shaped cells, and their microscopic pattern is not like that of this tumor. Plasma cell tumors have been reported as being multiple in the small bowel, but their microscopic recognition is easy, and individual cells resemble plasma cells. Lymphosarcomas do not usually show multiple nodules in the small bowel unless the process is fairly extensive, and this slide does not show any of the characteristics of lymphosarcoma. Metastatic neoplasms, when they involve the small bowel, usually grow in the submucosa. Such neoplasms usually occur when the process is extensive. However, in some instances the primary lesion can be small. This is particularly prone to occur in malignant melanomas. Questionable but not definite melanin pigment is seen. This patient should be questioned carefully about the removal of a previous mole. The time interval between the removal and the appearance of this tumor could be long—even ten years. I believe that other lesions will eventually develop, and the patient will eventually die of this process."

Follow-Up.—The patient was seen on Nov. 27, 1948, when he had the appearance of perfect health. He stated that he had not noticed any abnormal

coloration of his stools since returning home early in August. He had gained weight up to his normal of 165 pounds (74.8 Kg.). His hemoglobin level was 85 per cent, with an erythrocyte count of 4,400,000.

He was examined again for any evidence of other primary malignant tumor, and nothing suggestive was found. He does have numerous pigmented moles distributed over his body, but none suggested malignant change, and he does not know of any of them having changed color or enlarging. He has never had any moles removed.

The ultimate prognosis is, of course, guarded at best, in spite of the favorable condition at the present time.

COMMENT

A discussion of all the tumors of the small intestine is not within the province of this paper, but a brief consideration of the circumstances present may be in order.

Malignant tumors of the small intestine are not rare, but they are certainly uncommon. During a period of thirty-two consecutive years only 108 malignant tumors of the small intestine were encountered at the Mayo Clinic.¹

Multiplicity is noted in a small percentage of patients having malignant tumors, the number varying from 0.86 to 4.7 per cent (Abell).² Slaughter, in a detailed analysis of multiple primary malignant tumors, recorded 1,868 cases for which he could find suitable records. In 749 of these there were multiple lesions in one organ, and of these only four were of the small intestine—three in the ileum, one in the duodenum and none in the jejunum.³

The accepted criteria for the diagnosis of multiple primary malignant tumors⁴ are not fulfilled by the present case, principally because the two lesions have identical gross and microscopic structure but also because there are difficulties in proving that one lesion was not secondary to the other or that both were not metastatic from some unknown focus.

Bleeding is an expected symptom of tumors of the small intestine, but it is more commonly as occult blood in the stool than as a massive hemorrhage when it is the only presenting symptom. Massive hemorrhages are more likely to be from benign tumors of this locality than

1. Mayo, C. W.: Carcinoma of the Small Intestine, *West. J. Surg.* **48**:403, 1940.

2. Abell, I.: Multiple Primary Malignant Growths, *South. Surgeon* **2**:39 (March) 1933.

3. Slaughter, D. P.: The Multiplicity of Origin of Malignant Tumors, *Internat. Abstr. Surg.* **79**:89 (Aug.) 1944.

4. Eisenstaedt, J. S.: Multiple Primary Malignant Tumors, *J. A. M. A.* **110**:2056 (June 18) 1938. Hurt, H. H., and Broders, A. C.: Multiple Primary Malignant Neoplasms, *J. Lab. & Clin. Med.* **18**:765 (May) 1933.

from malignant ones.⁵ If massive hemorrhage from one malignant lesion in this region is uncommon, then the same thing from a second lesion must be even less frequent.

This case demonstrates some of the difficulties of making a diagnosis of tumors of the small intestine. To make the diagnosis one must first think of the possibility of such a lesion; symptoms are often vague and in most cases are not distinctive of the level of the tumor. Specific symptoms consist primarily of obstruction or bleeding.⁶ Roentgenologic studies of the small intestine may identify a tumor of this type, but special technics are usually required.⁷ Some are palpable when first seen, but they are apt to be inoperable at that time. Siper and Wood stated in a summary that the "clinical diagnosis of any tumor of the small bowel is usually quite a difficult procedure and as often made on the basis of a systematic elimination of the possibilities that the lesion is in some other organ."⁸ Bleeding which produces melena without hematemesis is more likely to have its origin below the ligament of Treitz than above it (Smith, Good and Gray),⁹ and exploratory laparotomy has a recognized role in the diagnosis of lesions of this type when there is bleeding from the intestinal tract for which no source can be found in the esophagus, stomach, duodenum or colon.

The only treatment of curative value is surgical extirpation, and the prognosis is bad in cases of malignant growths. As Fraser described it, "bad in the immediate future because so many are obstructed when first seen, and bad in the distant future because of the frequency of metastases."¹⁰ McDougal estimated the incidence of five year sur-

5. Bockus, H. L.: *Gastroenterology*, Philadelphia, W. B. Saunders Company, 1946. Mourot, A. J., and Watkins, C. H.: *Tumors of the Small Intestine*, *Am. J. Surg.* **73**:385 (March) 1947. Good and McCarty, cited by Mourot and Watkins.

6. Medinger, F. G.: *Malignant Tumors of Small Intestine: Incidence and Diagnostic Characteristics*, *Surg., Gynec. & Obst.* **69**:299 (Sept.) 1939.

7. Doub, H. P.: *Malignant Tumors of the Small Intestine*, *Radiology* **49**:441 (Oct.) 1947. Root, J. C.: *Roentgenologic Diagnosis of Tumors of the Small Intestine*, *M. Clin. North America* **32**:436 (March) 1948. Miller, E. R., and Herrmann, W. E.: *Argentaffin Tumors (Carcinoids) of Small Bowel: Roentgen Sign of Malignant Change*, *Radiology* **39**:214 (Aug.) 1942.

8. Siper, J., and Wood, E. C.: *Metastatic Melanocarcinoma Involving the Small Intestine and Brain*, *New England J. Med.* **236**:824 (May 29) 1947.

9. Smith, L. A.; Good, C. A., and Gray, H. K.: *Tumor of the Small Intestine as the Cause of Recurrent Melena: Report of Two Cases*, *Proc. Staff Meet., Mayo Clin.* **19**:117 (March 8) 1944.

10. Fraser, K.: *Malignant Tumours of the Small Intestine: A Review of the Literature and Report of Twenty-One Cases*, *Brit. J. Surg.* **32**:479 (April) 1945.

vivals at 5 per cent—a striking contrast to the approximate 50 per cent of patients having carcinoma of the colon who survive five years.¹¹

In conclusion, a report is made of a patient who had repeated massive gastrointestinal hemorrhages, ultimately proved to have their origin in two distinct malignant tumors of the jejunum, which were resected with an intervening interval of ten weeks. No claim is made that the lesions were definitely independent primary tumors, although some are of the opinion that they were. The pathologic diagnosis has been that the lesions were malignant without question, though the type is not definite, a carcinoid, a primary leiomyosarcoma, a metastatic melanoma and a metastatic leiomyosarcoma having been considered. Symptoms and findings which may suggest the diagnosis of tumors of the small intestine are briefly discussed. In questionable cases exploratory operation may be the only means of recognition.

11. McDougal, W. J.: Carcinoma of Small Intestine, *Am. J. Surg.* **66**:119 (Oct.) 1944.

DISCUSSION

DR. JAMES A. JACKSON, Madison, Wis.: I should like to reiterate the fact that in severe intestinal hemorrhage of unexplained origin the value of early roentgen examination of the small intestine is of utmost importance, and I wish to review briefly a case that we encountered approximately six months ago.

A woman came to the clinic evidently having severe intestinal hemorrhages. No definite diagnosis of the source of this hemorrhage was made until she had made two or three visits. Her hemoglobin concentration was low; the red blood cell count was about 1,000,000. Finally, a roentgen examination of the small intestine demonstrated an involvement of the jejunum by a tumor mass.

I operated on this patient and found a carcinoma of the jejunum which had involved most of the small intestine by direct extension between adjacent loops. There was no apparent involvement of the mesentery, and in attempting a resection I found it necessary to remove practically the whole jejunum and ileum. In fact, if the anatomists are correct in saying there are 20 feet (660.4 cm.) of small intestine, I removed approximately 18½ feet (564 cm.). A pathologic examination demonstrated no lymphatic involvement in spite of a careful study. This phenomenon seemed highly improbable considering the extent of the lesion.

It has been approximately six months since the operation, and the patient has made an uneventful recovery so far. She has about 8 inches (20 cm.) of jejunum and ileum left, that is, about 4 inches (10 cm.) of the jejunum and 4 inches of the ileum. We have been able to maintain her normal weight and with dietary control, and she has only two semisoft stools a day.

A review of the literature up to this time has revealed no case in which there has been such a massive resection of approximately 18½ feet of small intestine, with the patient surviving and apparently doing well after six months. If the patient is still alive next year, I hope to make a full report on the case at our meeting.

DR. RALPH H. LOE, Seattle, Wash.: This interesting paper illustrates the difficulty of the diagnosis of lesions of the small bowel. Several years ago Dr. Abbott pointed out that the Miller-Abbott tube was a valuable adjunct in the localization of lesions of the small bowel. In 1942 I had occasion to prove its

value in a patient who had had four massive hemorrhages of the upper part of the gastrointestinal tract. Repeated roentgen examinations and a gastroscopic examination had revealed no abnormalities. On her fourth admission to the hospital a Miller-Abbott tube was introduced into the duodenum, and when the tip had progressed to a point 1 foot (30.48 cm.) beyond the pylorus bright red blood was obtained by continuous suction. Surgical exploration revealed a small leiomyoma just beyond the ligament of Treitz, which I feel certain would have been missed without a rough idea of the localization of the source of difficulty.

DR. H. E. SNYDER, Winfield, Kan.: I have enjoyed this presentation very much. Malignant tumors of the small bowel are certainly infrequent. The variety of reports received on the tissue from these two rather innocuous-appearing lesions is indeed interesting.

When I was an intern at Pennsylvania Hospital in 1929, a man was admitted to the surgical service who had been operated on eighteen years previously by Francis T. Stewart. At that time a malignant lesion of the small bowel and jejunum had been removed, and the pathologist's diagnosis had been spindle cell sarcoma of the intestine. It was of such rarity that the specimen was put in the museum of pathology.

After an examination of this patient and the finding of a retroperitoneal mass, and biopsy thereof, we were able to compare sections from the lesion which appeared in these retroperitoneal lymph nodes eighteen years after the original tumor. Both appeared identical. That man had lived eighteen years without symptoms.

I am sure we can appreciate Dr. Mills's and Dr. Clark's difficulty in offering some sort of prognosis in this case.

DR. O. R. CLARK, Topeka, Kan.: I have little to add except to thank the three discussers for their comments on the paper and the presentation of these other cases.

I might mention that in the cases of tumor of the small intestine which are found in the literature approximately one half of the tumors were found only incidentally either at autopsy or at operation, having produced no symptoms which would call attention to their presence.

POLYPOSIS OF THE COLON

E. LEE STROHL, M.D.
AND
GUY V. PONTIUS, M.D.
CHICAGO

DIFFUSE polypoid disease of the colon, or multiple polyposis by common usage, occurs infrequently. It has been recognized since 1863,¹ when the pathologic characteristics were described by Virchow.

The heredofamilial character,² the diffuse involvement of the colon,³ and the tendency to malignant change in early life make the disease significant.⁴ The cases may be divided into two major types, as suggested by Erdmann and Morris:

(1) Adult or acquired type, usually occurring in middle or late adult life and characterized by a prolonged history of colitis. There are fewer polyps throughout the colon in this type.

From the Department of Surgery, St. Luke's Hospital.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 3, 1948.

1. Virchow, R.: *Die krankhaften Geschwülste*.: Dreissig Vorlesungen, gehalten während des Wintersemesters 1862-1863 an der Universität zu Berlin, Berlin, A. Hirschwald, 1863, p. 242.

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4. (a) Erdmann, J. F., and Morris, J. H.: *Polyposis of the Colon: A Survey of the Subject*, *Surg., Gynec. & Obst.* **49**:460-468 (April) 1925. (b) Jackman, R. T.: *Relationship of Polyps of Colon to Cancer*, *Proc. Staff Meet., Mayo Clin.* **16**:11-12 (Jan. 2) 1941. (c) McLaughlin, C. W., Jr.: *Diffuse Polypo-*

(2) Adolescent (congenital disseminated) type occurring in youth or young adult life. A history of a similar condition may be obtained from other members of the family. The symptoms are recurrent episodes of abdominal discomfort, associated with cramps and bloody diarrhea. The colon is usually diffusely studded with polyps from the cecum to the anus. The polyps are not present in the susceptible persons at birth but appear in childhood or near the age of puberty. This factor results in much difficulty in classification. It therefore necessitates a careful elicitation of the history and thorough examination of other members of the family to establish a diagnosis of heredofamilial polyposis.

Irrespective of the basis on which polyposis develops, the incidence of carcinoma is unusually high. Scarborough stated that "probably no benign process has a higher incidence of malignant degeneration than polyposis." In his collected series the incidence of carcinoma was found to be above 50 per cent. Hullsiek reported that 34.6 per cent of his collected series presented evidence of malignant degeneration. We think that carcinoma of the large bowel or rectum will develop in 100 per cent of patients with polyposis of the colon if they survive a sufficient number of years. Persons with the heredofamilial form of the disease tend to exhibit malignant degeneration at a younger age than those with the acquired form of the disease.⁵

Other complications of the disease are anemia and wasting, secondary to the prolonged diarrhea and loss of blood.⁶ Partial or complete

sis of the Large Intestine, *Am. J. Surg.* **62**:258-266 (Nov.) 1943. (d) Miller, R. H., and Sweet, R. H.: Multiple Polyposis of the Colon: Familial Disease, *Ann. Surg.* **105**:511-515 (April) 1937. (e) Pfeiffer, D. B., and Patterson, F. M. S.: Congenital or Hereditary Polyposis of the Colon, *ibid.* **122**:606-624 (Oct.) 1945. (f) Pugh, H. L., and Nesselrod, J. P.: Multiple Polypoid Disease of the Colon and Rectum, *ibid.* **121**:88-99 (Jan.) 1945. (g) Rankin, F. W.: Colectomy for Adenomatosis and Pseudopolyposis, *ibid.* **102**:707-723 (Oct.) 1935; (h) Multiple Polyps of the Colon, *South. M. J.* **27**:574-578 (July) 1934. (i) Wesson, H. R., and Bagen, J. A.: Classification of Polyps of the Large Intestine, *Proc. Staff Meet., Mayo Clin.* **9**:789-794 (Dec. 26) 1934.

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(Footnote continued on next page)

obstruction incident to enlargement of the polyps has been observed. Intussusception of various segments of the colon may be expected.

It is the purpose of this paper to present 3 cases of polyposis of the colon occurring in young adults, with cancerous degeneration in the involved colon.

CASE 1.—History.—A. W. T., a 46 year old white man, entered St. Luke's Hospital on Sept. 17, 1940. He complained of abdominal distention following meals and frequent stools, with occasional bloody diarrhea, of four years' duration. He lost 20 pounds (9.1 Kg.) in weight during the preceding nine months. Although the symptoms extended over a four year period, medical consultation was sought only after friends had commented on his progressive loss in weight.

The past history was noncontributory. The family history revealed that his father died at the age of 72 of recurrent cancer of the colon. His maternal grandfather died at 72 of cancer of the stomach. One sister died at 25 after perforation of a cancer of the colon. His mother was living and well at 81 years.

Proctoscopic Examination.—Many polyps were seen, both sessile and pedunculated, with a fungating annular cancer of the rectum at 14 cm. A specimen of the tumor was removed for microscopic study.

Roentgenologic Examination.—Barium enema revealed a filling defect of the rectosigmoid, with questionable polyps of the entire colon above the lesion.

After a few days' preparation with administration of sulfaguanidine, low residue diet, transfusions and vitamin therapy, the patient was operated on on Oct. 4, 1940.

Surgical Procedure.—A low midline incision was made. Exploration revealed the entire descending colon, transverse colon, ascending colon and cecum filled with polyps of varying sizes. Just below the peritoneal reflection was an ulcerated carcinoma. Many regional lymph nodes were palpable. The liver was normal on palpation. The operation was completed as an abdominoperineal resection. The postoperative course was uneventful, the patient being discharged on the eighteenth postoperative day.

Pathologic Changes.—The excised surgical specimen comprised 36 cm. of colon and rectum (fig. 1). The entire mucosa was studded with polyps, ranging in size from 3 mm. to as much as 3 by 1.7 by 1.3 cm. Most of the polyps were pedunculated, a few being sessile. Fourteen centimeters above the anal ring was a lesion 7.5 by 5.5 cm., with a raised margin and ulcerated base. Microscopic study revealed a carcinoma. Immediately above the carcinoma were larger pedunculated polyps, one measuring 6 by 5 cm. This large polyp was interpreted as papillary carcinoma. No metastatic cancer was found in the lymph nodes (fig. 2).

Subsequent Course.—In May 1948 the patient reentered St. Luke's Hospital for a routine examination. During the seven and one-half year interval, he had been in excellent health. On one occasion there had been slight bleeding from the colostomy opening for a few days.

Examination of the stoma with a proctoscope revealed the colon studded with polyps of varying sizes.

of the Colon: Familial Character and Malignant Tendency, J. A. M. A. **107**:1871-1876 (Dec. 5) 1936. Wilensky, A. O.: Total Colectomy for Polyposis of the Colon with Carcinomatous Degeneration, Surgery **17**:630-634 (April) 1945. Miller and Sweet.^{4d} Pfeiffer and Patterson.^{4e} Wesson and Bargen.^{4f}

Roentgenologic examination revealed polyps throughout the remainder of the colon visualized. Roentgen studies of the chest showed no abnormalities. The blood and urine were normal.

Comment.—The patient has refused further surgical intervention for complete removal of the involved colon. He realizes the hazard he is taking. We think that his polyposis may be the congenital disseminated type, in view of the occurrence of carcinoma of the colon in his father at the age of 72 and in one sister at the age of 25. It is possible that this is an acquired type; however,

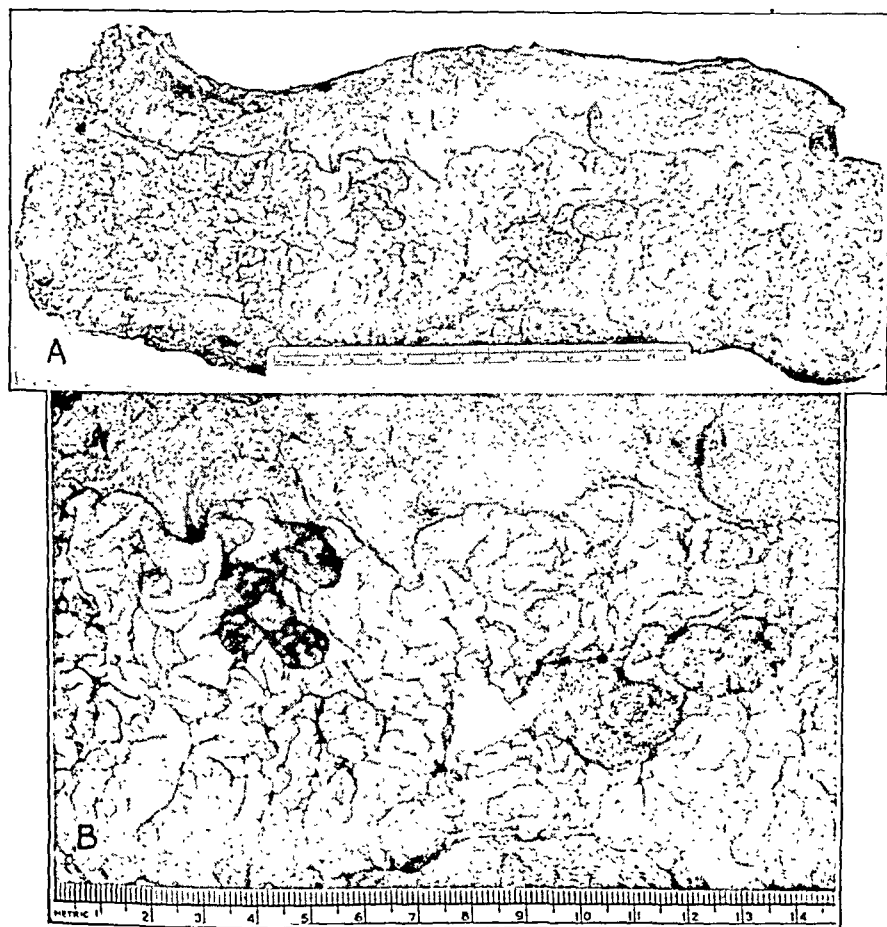


Fig. 1.—*A*, the surgical specimen showing many polyps and the two large polyps which caused the filling defects seen on roentgen examination. *B*, high power magnification showing many polyps with areas of normal mucosa between them. The cancer was demonstrated by proctoscopic examination and by the filling defects on roentgenologic examination.

the history does not bear out long-standing disease of the colon. The appearance of symptoms at the age of 42 is late for the congenital disseminated type.

CASE 2.—History.—S. R., a 29 year old unmarried woman, entered St. Luke's Hospital on March 11, 1946. She complained of vomiting and cramping mid-abdominal pain of twelve hours' duration. The pain was intermittent in character, occurring at three to five minute intervals. One year previously she had been hospitalized elsewhere for a similar type of distress. She had been discharged

after roentgen studies of the stomach and gallbladder, with a diagnosis of "nervous stomach." During the interval she had been in excellent health.

The family history revealed that her father died at the age of 42 of cancer of the colon and one sister died at 23 of a tumor of the large bowel. A second sister died at 28 of ulcerative colitis. A third sister died at 20 after appendectomy, and after the operation the surgeon told the family that she had had a malignant growth of the large bowel.

Laboratory Studies.—Laboratory studies revealed a red blood cell count of 3,880,000 per cubic millimeter. The hemoglobin content was 7.3 Gm. per hundred cubic centimeters. The leukocytes numbered 7,300 per cubic millimeter.

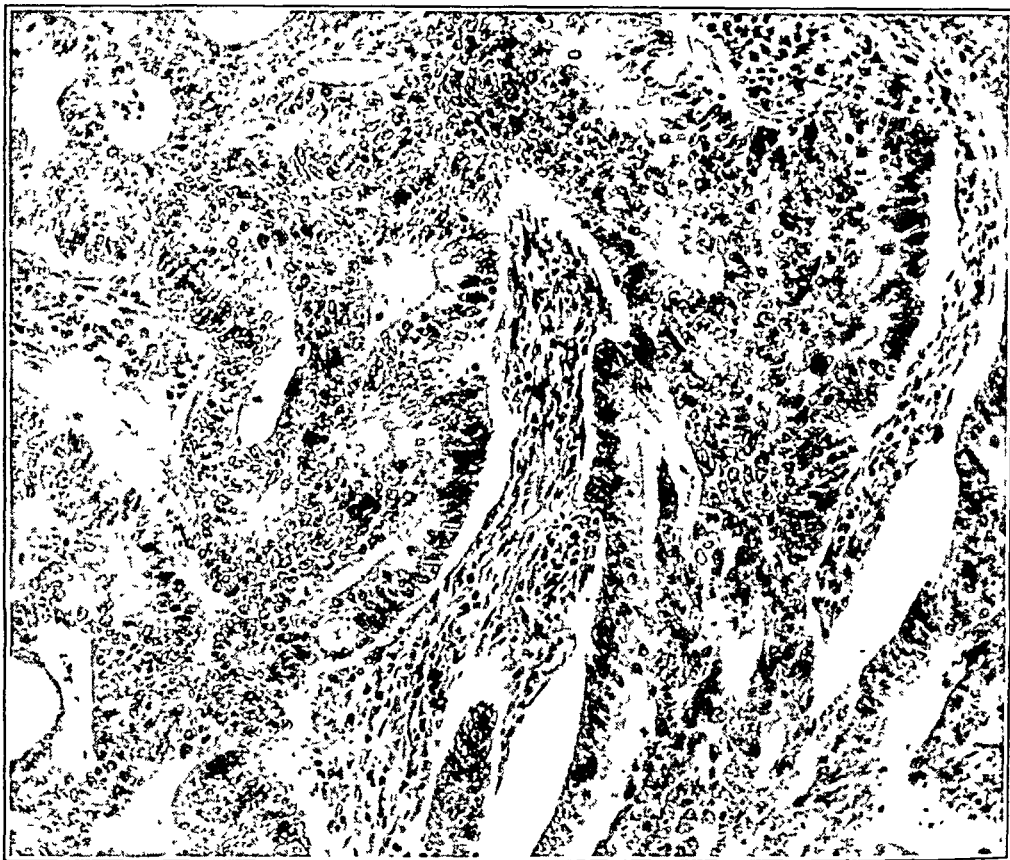


Fig. 2.—Tissue removed from the cancer. The epithelial masses have odd tubule-like lumens. The cells are in several layers, and among them are many in mitosis.

The differential count was normal. The sedimentation rate was 31 mm. in one hour. Examination of the stools revealed occult blood (4 plus). No organisms of the typhoid, paratyphoid or dysentery groups were identified. Chemical examination of the blood and studies of the urine revealed no abnormalities.

Proctoscopic Examination.—Many polyps were seen, both sessile and pedunculated, throughout the entire 22 cm. visualized.

Roentgenologic Examination.—A thin barium enema revealed a long filling defect, measuring 12 to 14 cm., of the midtransverse colon, extending to the hepatic

flexure. The patient was prepared for surgical treatment with suction decompression, blood transfusions, vitamin therapy and administration of parenteral fluids.

Surgical Procedure.—On March 21, 1946, a transverse incision in the upper abdominal region was made. The liver was normal grossly. There were many soft, enlarged lymph nodes in the transverse mesocolon. A constricting lesion was found in the transverse colon. The entire colon, proximal to the lesion, was filled with large and small polyps. A side to side ileotransverse colostomy was made. The cecum, ascending colon and much of the transverse colon were resected. The postoperative course was uneventful, and the patient was discharged from the hospital on the sixteenth postoperative day.

Pathologic Changes.—The surgical specimen consisted of 15 cm. of ileum, the cecum, ascending colon and transverse colon, a total of 40 cm. of large bowel.

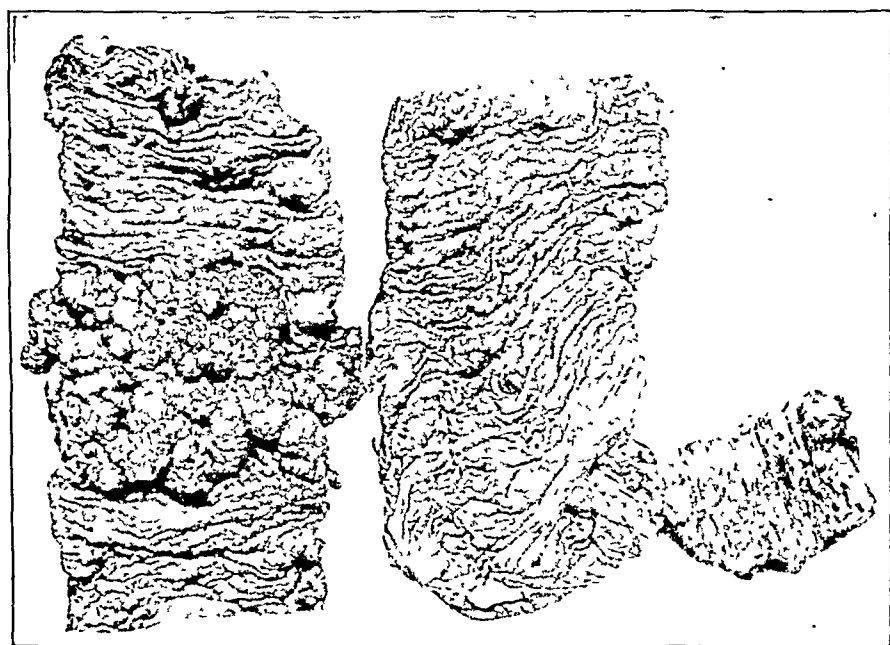


Fig. 3.—Surgical specimen showing the cancer. Both sessile and pedunculated polyps are seen.

Scattered polyps, ranging in size from 4 mm. to 2 cm., both sessile and pedunculated, were found. An annular carcinoma was found in the transverse colon extending 9 cm. longitudinally (fig. 3). Microscopic examination revealed glandular and papillary carcinoma (fig. 4). The regional lymph nodes contained metastatic carcinoma.

Subsequent Course.—The patient returned one year later for examination. She was in excellent health and had no complaints.

Laboratory Studies.—The blood counts, the chemical composition of the blood, the stools and the urine were normal. A roentgenogram of the chest was normal. Proctoscopic examination revealed many polyps, sessile and pedunculated, throughout the entire 25 cm. visualized. A thin barium enema revealed many polyps in the remaining colon.

Comment.—We think that this patient had adolescent or congenital disseminated polyposis, because her father died at 42 of cancer of the colon, one sister died at 23 from a malignant process of the large bowel, a second sister died at 28 of ulcerative colitis and a third sister died at 20 after appendectomy, at which time it was discovered she had a malignant growth of the large bowel.

Further surgical intervention should be carried out; however, this recommendation has been refused repeatedly.

CASE 3.—History.—R. R. H., a white housewife aged 37, entered St. Luke's Hospital on April 30, 1941. She complained of intermittent diarrhea and bloody stools of seven years' duration. Previous to her admission to the hospital, *Amoeba histolytica* was found in the stools, and treatment had been instituted elsewhere.

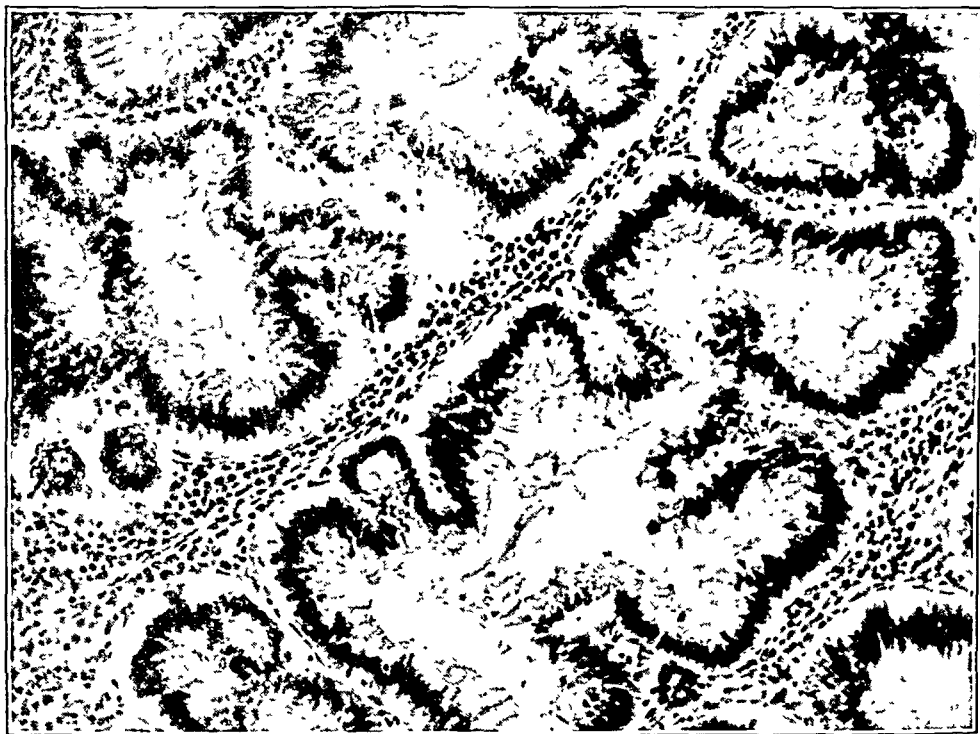


Fig. 4.—Mucoid degeneration of the cancer cells. Atypical glandular tissues with supporting stroma.

Recent examination of stools revealed no amebas, although diarrhea and bloody stools persisted. The family history was noncontributory. She was the mother of three healthy children, aged 8, 5, and 2 respectively.

Physical Examination and Preoperative Studies.—The physical examination revealed a healthy woman. The temperature, pulse and respirations were normal. The abdomen was normal. Pelvic and rectal examination showed no abnormalities. Laboratory studies revealed 3,890,000 red blood cells per cubic millimeter. The leukocytes numbered 5,650 per cubic millimeter. The hemoglobin content was 10.5 Gm. per hundred cubic centimeters. The sedimentation rate was 8 mm. in one hour. Chemical studies of the blood revealed no abnormalities. A roentgenogram of the chest was normal.

Examination of the stools revealed a 3 plus reaction to the benzidine test for blood, with no amebas or cysts in the liquid stools.

Proctoscopic Examination.—The rectum was studded with polyps varying in size from 3 mm. to 1 cm., some being sessile and others attached by narrow pedicles. At 14 cm. there was a large ulcerated lesion surrounded by polyps, growing in an annular fashion. The instrument was not passed beyond the lesions. A specimen of the tumor removed at the time of the examination revealed cancer.

Roentgenologic Examination.—A thin barium enema revealed a constricting annular lesion of the rectosigmoid, interpreted as a malignant growth, with many



Fig. 5.—Barium enema through colostomy opening revealing an annular constricting lesion of the transverse colon.

polyps of the entire colon. After a few days' preparation with sulfaguanidine, a low residue diet, transfusions and vitamin therapy, the patient was operated on May 15, 1941.

Surgical Procedure.—A low midline incision was made. Palpation revealed polyposis of the entire colon, with an annular lesion at the peritoneal reflection. The liver was normal grossly. Many soft lymph nodes were palpable in the mesocolon. The operation was completed as an abdominoperineal resection. Sterilization was accomplished at the time of operation by ligation of the fallopian tubes. During the convalescence, the colostomy opening was examined through a cystoscope, and many polyps were visualized. The convalescence was uneventful, and she was discharged eighteen days after the operation.

Pathologic Changes.—The excised surgical specimen comprised 39 cm. of colon and rectum. The entire mucosa was studded with polyps ranging in size from 3 mm. to 3.5 cm. Some were attached by narrow pedicles, and others were sessile. The longest pedicle was 5 cm. Twelve centimeters above the anal orifice was a constricting annular lesion. The mucosa above and below the lesion contained numerous polyps. Microscopic examination revealed the constricting lesion to be carcinoma. All the polyps were benign. Metastatic cancer was found in the regional lymph nodes.

Subsequent Course.—The patient was in good health until January 1944, when intermittent pain, with obstructive features, developed. At that time she was readmitted to St. Luke's Hospital. Studies of the remaining part of the colon revealed an annular constricting lesion with polyps (fig. 5). A roentgenologic

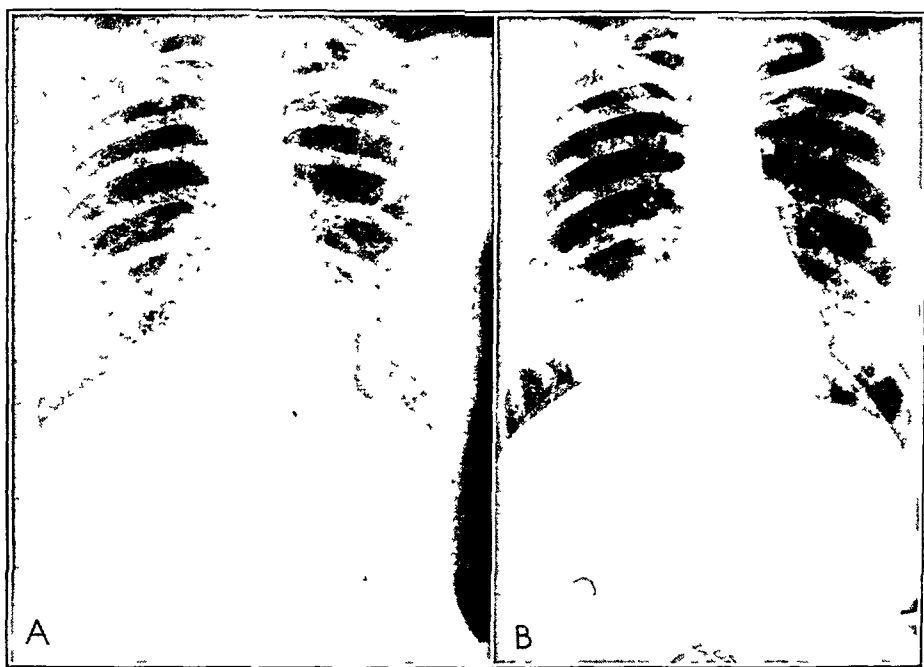


Fig. 6—*A*, small lesion above the diaphragm interpreted as the residues of recent pneumonia. The possibility of this area being metastatic was considered. *B*, nodular, rounded shadow, clearly demarcated, in the right cardiophrenic angle, which has the appearance of a solid tumor mass

examination of the chest at that time revealed a small lesion of the right side, interpreted as the residue of pneumonia (fig. 6 *A*). On Jan. 26, 1944, two years and nine months after the abdominoperineal resection, exploration was carried out through a transverse incision in the upper abdominal area and the remaining part of the colon resected. Ileostomy was performed in the right lower quadrant. Lymph nodes of generous size were encountered. The postoperative course was uneventful, and the patient was discharged on the fourteenth day.

Pathologic Changes.—The excised surgical specimen comprised 60 cm. of colon and 8 cm. of ileum. Thirty-eight centimeters proximal to the colostomy opening, in the transverse colon, was an annular cancer involving the entire wall. Proximal and distal to the lesion, the mucosa was studded with polyps, ranging

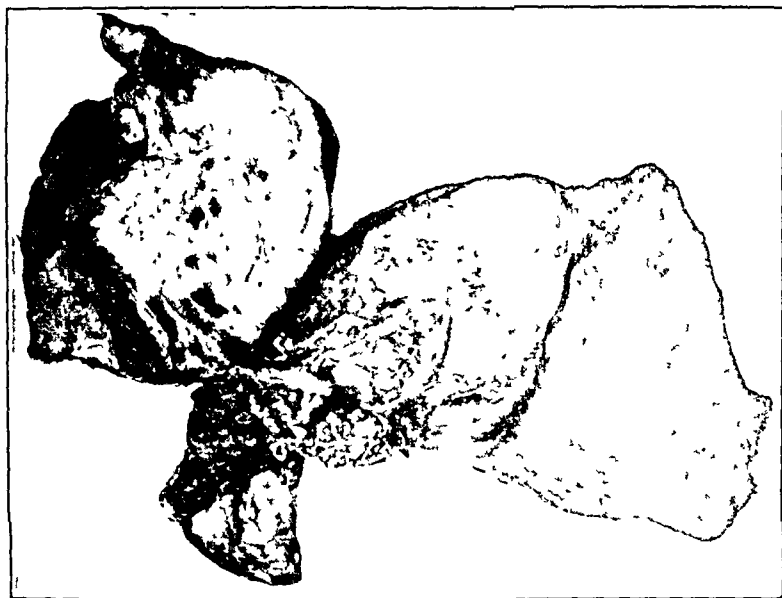


Fig. 7.—Metastatic cancer of the lung. The primary lesion was a cancer of the colon.

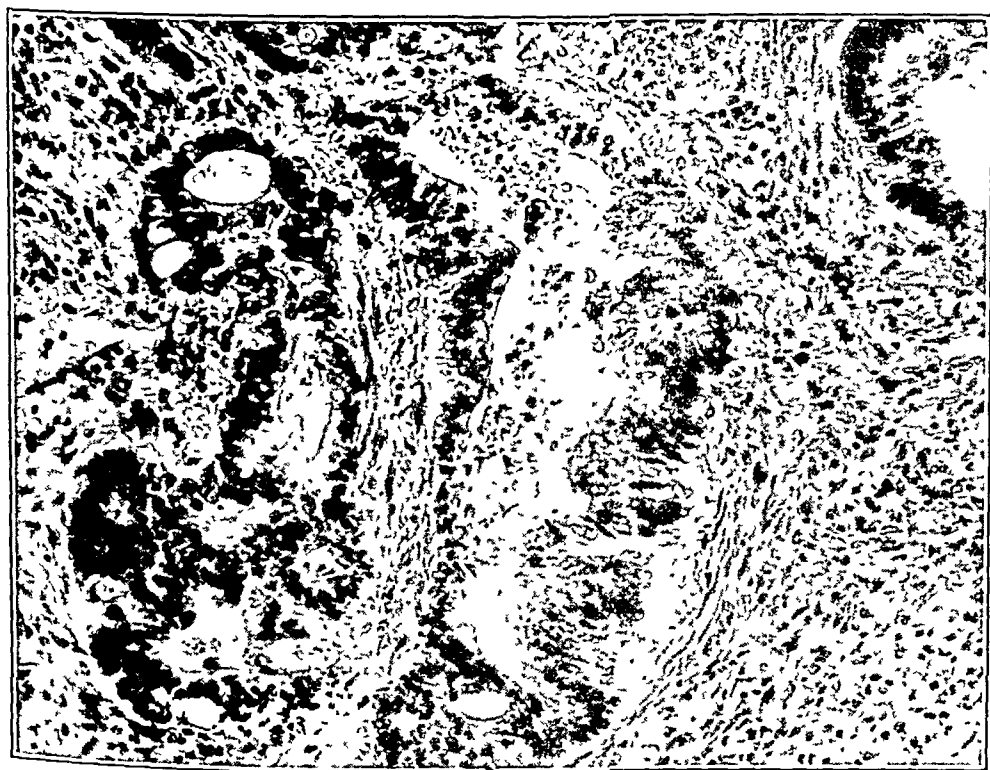


Fig. 8.—The structure of this tumor tissue corresponds to that of a carcinoma of the colon. The cells lining the gland structures are columnar in several layers.

in size from 1 to 5 mm., being both sessile and pedunculated. Regional lymph nodes contained metastatic cancer.

Subsequent Course.—The patient was in good health until November 1945, twenty-three months after the second resection of the colon for cancer. A roentgenogram of the chest revealed a nodular, rounded shadow, clearly demarcated in the right cardiophrenic angle which had the appearance of a solid tumor (fig. 6B). This mass had been interpreted as the residue of pneumonia twenty-three months previously. Bronchoscopic examination revealed obstruction of the lower part of the bronchus on the right, with soft granular tissue present. Microscopic examination of the tissue revealed metastatic carcinoma, the pathologist reporting that the primary lesion arose in the colon.

Surgical Procedure.—On Nov. 2, 1945, thoracotomy was done on the right side and excision of the lower lobe on the right performed.

Pathologic Changes.—The surgical specimen revealed glandular metastatic carcinoma of the lung, with metastasis to lymph nodes (fig. 7). The structure of the tumor tissue corresponded to the primary carcinoma of the rectosigmoid (fig. 8).

The postoperative course was uneventful. The patient was discharged, and she carried out an active life for six months. After that time two firm nodules of the scalp and cranium developed and grew rapidly in size. A few days later dysarthria, drooping of the left side of the lower lip and loss of memory for recent events developed. Roentgen ray therapy was suggested; however, the patient died in her home on March 10, 1946, fifty-eight months after the abdominoperineal resection for cancer of the rectosigmoid, with metastatic involvement, and twelve years after the onset of symptoms of diarrhea and bloody stools.

Comment.—We think that this patient had congenital disseminated polyposis, although no other members of the family showed evidence of the disease. We are uncertain whether the intrathoracic metastasis originated from the rectosigmoid cancer or from the cancer of the transverse colon. In each instance of resection of the colon, regional lymph nodes were involved with metastatic cancer.

DISCUSSION

DR. GUY V. PONTIUS, Chicago: The treatment of heredofamilial polyposis is complete colectomy. This should be done because of the strong carcinogenic factor in this disease. Most patients with this type of polyposis will die of carcinoma in the second or third decade, if untreated. It is unusual for such a patient to live beyond the fifth decade without the development of carcinoma of the colon.

Before subjecting a patient to such a radical procedure as colectomy, every caution should be exercised to distinguish this condition from that of multiple, isolated polyps. For such a lesion the removal of the individual tumors is adequate treatment. The carcinogenic factor, while present, is not nearly as strong. In contradistinction to multiple isolated polyps, in heredofamilial polyposis the entire colon, or a large segment of it, is the seat of many polyps varying from a minute size to several centimeters in diameter, both pedunculated and sessile in form. In gross appearance such polyps resemble shag carpeting. A careful elicitation of the history and investigation of blood relatives, will help establish the genetic factor.

The plan of operative procedure will depend on two factors: (1) the condition of the patient, and (2) whether carcinomatous degeneration has occurred. With no evidence of carcinoma, and if the patient is in good condition, ileostomy and complete colectomy may be accomplished in two stages. If for any reason consid-

erable time must elapse between stages, it is well to plan colectomy on the left side first. The vulnerability to malignant degeneration of the left side of the colon versus the right side is comparable to that in carcinoma of the normal colon.

After carcinoma has developed, the plan of procedure is the same as for carcinoma in the normal colon. The advisability and the time for completion of the colectomy are difficult problems. If one is in doubt as to whether the carcinoma has been completely eradicated and if the patient is symptom free it is debatable whether colectomy should be completed. It would seem unreasonable to subject a patient to total colectomy only to have him die of metastatic cancer from the primary lesion. The risk of the development of another carcinoma in the remaining segment must be intelligently weighed.

When these points were discussed with our 3 patients, each elected to wait a three year period unless symptoms developed signifying malignant degeneration in the remaining part of the colon. All submitted to periodic observation.

Ravitch in a recent publication has reported 2 cases of anal ileostomy with preservation of the sphincters and good functional results. The operation in these cases was done for chronic ulcerative colitis. If this procedure proves satisfactory, it should lessen the reluctance of patients to accept complete colectomy.

DR. ROBERT W. BARTLETT, St. Louis: I agree with the essayists, the Lahey group and others that in resection in these cases the rectum should in most instances be included, and subsequently a permanent ileostomy performed. To eliminate the undesirable features of the permanent ileostomy we have adopted the method of exteriorization of 5 or 6 inches (12.7 to 15 cm.) of the distal end of the ileum, with immediate split thickness skin graft of it, as described by others, and we find this method most satisfactory.

To demonstrate this point, a young man has come some 200 miles today for your inspection. He is a 23 year old veteran who had bleeding off and on for the past four years. He came to us last summer with the complaint of an increased amount of bleeding for three weeks and considerable loss of weight. Last June his operative procedures were started.

(Slide) It was determined, of course, that he had multiple polyposis, and we did first of all a combined abdominoperineal excision and found in the mid-sigmoid, where the pointer indicates, an obvious carcinoma the size of a quarter. It had not been picked up on roentgenograms because it was too small. There was no evidence of metastasis.

(Slide) This is a low power photomicrograph of the carcinoma. We sent the boy home for a month and then brought him back to complete the colectomy as a second stage operation, and that was carried out the middle of last August.

(Slide) I received this slide just yesterday, and the specimen will have to be rephotographed. It is not a satisfactory picture. The polyps extended to the proximal transverse colon, and in the descending colon a second polyp had undergone malignant degeneration. This patient had two accidentally found early carcinomas.

(Slide) This shows a malignant polyp.

(Slide) This is the high power magnification showing that the growth is clearly malignant. At the time of the second operation we did exteriorize the distal end of the ileum and skin grafted it, and the patient made a satisfactory recovery.

(Slide) This is the skin-grafted organ, which has all the appearances of a penis, and is located in the right lower quadrant.

(Slide) This is a lateral view of the ileostomy. The first stage of the resection was through a left rectus incision, and the second stage was through a transverse incision.

(Slide) This young man wears a Koenig-Rutson air-tight bag. He has five or six semisoft stools each day and goes about his normal life. He is driving to Peoria today to the Hiram Walker Distillery to start work as a guard there. He does not get up at night, and there is no odor. He tells me he was out hunting last week. I think this probably solves the problem of permanent ileostomy.

(Demonstration) In order to remove this air-tight bag he has to use a little ether to melt the cement on his skin. If anyone is interested in seeing the skin-grafted, exteriorized ileostomy opening, I will have the young man at the back of the room for observation after the last paper is presented this morning.

DR. JOHN H. WOOLSEY, Woodland, Calif.: I should like to discuss two points in regard to the paper just presented. I noticed that in the summary the authors said they would show the typical roentgenologic findings. I did not see them shown, nor did I hear them discussed, and I hesitate to speak about it because I think all of us probably are familiar with the so-called contrast enema.

We have found that in the confirmation of the diagnosis and proof of this the so-called contrast enema demonstrates it practically 100 per cent. First the patient is prepared. It is most important to be certain that all fecal material is absent. Then the barium enema is given and the patient is allowed to have a bowel evacuation, and then inflation of the bowel is done. Further roentgenograms are then taken, which show the polyps clearly standing out as stalactites. It is really the final proof.

One of the authors spoke about the length of time required and the seriousness of a colectomy. In handling such a lesion we perform the operation as Dr. Henry Cave has suggested it be performed for ulcerative colitis, namely, by the use of the Miller-Abbott tube. If it is passed into the small intestine and this intestine completely emptied, it makes the operation much easier, and the total procedure can be done quickly, in about one third of the time, and with far less shock to the patient.

DR. C. J. HUNT, Kansas City, Mo.: I am very much interested in this subject of polyposis of the colon, because I am sure that polyps of the colon are a good deal like gallstones—they are not innocent. They lead to ultimate complications, and in this instance they led to a malignant process.

Too often when we make a diagnosis of cancer of the rectum or colon we think the problem of the study of the bowel is completed. We proceed to remove the lesion without making further investigation of the colon to see if there is another cancer or if there are associated polyps. It is wise to find out whether there are polyps that are associated with the malignant lesion and, if there are, whether they are in such a position that, by extending the field of operation, the malignant lesion along with the polyps can be removed.

Therefore, there are two avenues by which to study lesions of the colon and the rectum. Roentgenograms do not reveal accurately malignant lesions or polypoid lesions of the rectum and the rectosigmoid and that portion of the bowel below the pelvic peritoneum or below the lower part of the sigmoid. It is important to study these lesions by proctoscopic and sigmoidoscopic examination. One can then get a biopsy of the polyp and can determine its true cytologic structure.

In order to study the lesions above this region, one has to use roentgenologic investigation. A barium enema gives a great deal of information concerning the colon; it will tell you whether there is a narrowing constricting area of the colon, whether there is an obstruction or whether there is gross deformity of the colon. However, the barium enema itself will cover up the mucosal pattern and you cannot tell a thing about it. You have to do as Dr. Woolsey has suggested, that is, study the entire colon above this area by barium enema and by contrast enema after the opaque medium has been evacuated. Then you can see the opaque medium hanging onto these polypoid projections in the colon and can make a diagnosis of them.

I think we should all establish the principle of studying the entire colon when we are confronted with a malignant lesion of the rectum and of the colon.

(Slide) This slide shows extensive polyposis of the colon in a woman of middle age. This patient refused operation at the time, but later was operated on elsewhere, and a colectomy was done. The colon was entirely studded with polyps.

(Slide) This patient is a man 73 years of age who presented himself with an advanced carcinoma of the rectum, which was removed by abdominoperineal resection. We gave a barium enema, and this patient taught us to give not only a barium enema but also a contrast enema.

On the portion of the bowel protruding through the left side we removed a polyp that was in this protruding portion of the descending colon. The polyp was malignant. We made further investigation of the colon, and subsequently it was removed, and this shows the specimen. (Slide)

(Slide) This slide is that of a woman 39 years of age who in January of this year underwent colectomy for a malignant lesion. She came to our community because her mother was in the hospital convalescing from a colectomy for a malignant lesion of the sigmoid. She spoke to us and told us of her previous operation and said that recently she had been passing some blood.

We examined her and found a lesion. We performed a biopsy, as we were able to approach it through the sigmoidoscope. We performed a colectomy low on the left side with primary anastomosis about six weeks ago. This case demonstrates that if there are associated polyps in the region of the malignant growth the extent of the operation can be expanded and those polyps can be removed along with the primary carcinoma. In order to determine this, one has to investigate the colon from the standpoint of contrast enemas and instrumentation from below. I believe that had the patient been examined by this method the scope of the operation could have been extended and the lesions could have been removed in one operation.

Incidentally, we had previously operated twice on a cousin of her mother for malignant lesion of the colon, colectomy having been performed on the right side in 1944 and on the left side in 1947. Undoubtedly, there were polyps present at the time of the first colectomy. We did not detect them by barium enema, and the patient subsequently returned. This illustrates the familial characteristics of polyps of the colon.

I have enjoyed this presentation because it is so practical.

DR. R. R. BEST, Omaha: I do not believe that I agree with all that has been said about sacrificing the sphincter mechanism in patients with polyposis of the colon. We are all acquainted with the procedure of anastomosing the ileum to the sigmoid in cases of polyposis of the colon after removal or destruction

of the polyps in the rectal and lower sigmoid regions with the electric current. It is another problem when polyposis of the colon plus carcinoma of the rectum is present, and in some of these cases one must sacrifice the sphincter mechanism. In some cases the polyps may be destroyed and then colectomy, in which the carcinoma is removed, may be accomplished, followed by anastomosis of the ileum to the rectal stump. About a year ago I reported on the experiences in 9 cases in which the ileum had been anastomosed to the anus or the lower rectal segment, and I must add that there is considerable difference between anastomosis of the ileum to the anus or the lower part of the rectum and anastomosis of the ileum to the sigmoid. This operation was originally planned for carcinoma of the rectum. At that time I was routinely removing the upper part of the sigmoid and even part of the descending colon in abdominal-perineal resection. Interested in preserving the sphincter mechanism and aware that downward spread in rectal carcinoma was unusual at a distance more than 2 cm. below the lower margin of the malignancy, and being unable to approximate the short rectal stump to the short descending colon, I transected the terminal end of the ileum and anastomosed it to the rectum or anus. The remaining part of the colon opened onto the abdominal wall as a small mucous fistula. The experiences which I had were not satisfactory, and my report was rather pessimistic. I did conclude that the operation of ileorectostomy or ileoproctostomy should be seriously considered for patients with polyposis of the colon and a malignant growth of the rectum. A permanent ileostomy may be avoided in some of these patients by this procedure. I do not believe that the operation of ileorectostomy or ileoproctostomy should be done on patients with carcinoma of the rectum unassociated with polyposis or in patients with ulcerative colitis. Therefore, in cases of polyposis of the colon associated with carcinoma of the rectum this procedure may be used and a permanent ileostomy avoided.

DR. ROGER VAUGAN, Chicago: Some five or six years ago I started one of our residents on the problem of graphing the intestinal sounds in 1,000 normal persons. About the twelfth case I discovered during a conversation that the patient suffered from multiple polyposis of the large bowel; he had been everywhere, and the only opinion he could get as to what to do with it was to have it resected.

Being a young man and because there was no evidence of any malignant process as yet, he was reluctant to have this resection done. He had had the polyps in his rectum fulgurated as far as the sigmoidoscope would reach, and he inquired of me whether I could think of any method by which he might avoid a colonic resection so long as no growths of carcinomatous aspect had yet appeared.

I happened to remember the old Rovsing gastroscope and how it was inserted in the stomach to hunt for the bleeding point of an ulcer through a suture-encircled opening, and I said: "I wonder whether you could introduce an esophagoscope or a sigmoidoscope through such a puncture procedure, and fulgurate these young lesions. You would need an incision through the sigmoid, and you would need an incision in the transverse colon. I do not know just how you would handle the flexures."

He was so intrigued that he forgot all about peristaltic sounds and went after polyps, and he used all our local endoscopic tools at the postgraduate school on dogs and cadavers and had a lot of roentgenograms taken of the tubes in situs. The upshot of it was that he wrote a paper which was accepted by the Chicago Surgical Society as the best original contribution for the year, and he received the annual \$500 prize of the society.

I have never had a case in which I could use this technic, and whether he ever had it used on himself or not I do not know. Certainly I did not do it. I offer this suggestion here since some of you will have such cases, and if you are intrigued with the idea, no doubt Dr. Cole can furnish the reference, since he has access to the Chicago Surgical Society's records.

SITUS INVERSUS TOTALIS

A Statistical Review of Data on Seventy-Six Cases with Special Reference
To Disease of the Biliary Tract

CHARLES W. MAYO, M.D.

AND

ROBERTA G. RICE, M.D.

Fellow in Surgery, Mayo Foundation

ROCHESTER, MINN.

“SITUS inversus viscerum” is a term used to designate an anomalous condition in which organs or systems are transposed from their normal sites to locations on the opposite side of the body. It may include complete transposition of both the thoracic and the abdominal viscera or of only one or the other.

Fabricius¹ in 1600 reported the first known case of reversal of the liver and spleen in man, and Kuchenmeister² in 1824 was the first to recognize the condition in a living person. To Vehsemeyer,³ in 1897, is given the credit for being first to demonstrate, by roentgen ray, transposition of the viscera.

During the years 1910 through 1947, of 1,551,047 patients registered at the Mayo Clinic, 76 were found on physical or roentgenologic examination, or both, to have a situs inversus of both thoracic and abdominal viscera. Seven others showed thoracic transposition only, and 4 more had transposition of the viscera that was confined to the abdomen. This gives an incidence of 0.00489 per cent for complete situs inversus, or 1 in 20,408 registrations. In the same period the condition was noted three times in 19,287 necropsies.

Adams and Churchill⁴ in 1937 found an incidence of complete situs inversus of 0.002 per cent in the patients admitted to Massachusetts General Hospital and an incidence of 1 in more than 8,000 necropsies performed there.

In 1923 Guenther⁵ gave the incidence of situs inversus as 0.0079 per cent, determined on the basis of clinical evidence, and as 3 in

From the Division of Surgery, Mayo Clinic.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 3, 1948.

1. Fabricius, cited by Wood and Blalock.¹⁰

2. Kuchenmeister, cited by Wood and Blalock.¹⁰

3. Vehsemeyer, cited by Wood and Blalock.¹⁰

4. Adams, R., and Churchill, E. D.: Situs Inversus, Sinusitis, Bronchiectasis: A Report of Five Cases, Including Frequency Statistics, *J. Thoracic Surg.* 7:206-216 (Dec.) 1937.

5. Guenther, H., cited by Adams and Churchill.⁴

22,000 routine necropsies. Cleveland⁶ in 1926 noted 1 example of complete situs inversus in 10,000 dissections, and Rösler⁷ in 1929 recorded 3 instances of complete situs inversus in 22,402 necropsies.

Cockayne⁸ gave the ratio of males to females with complete transposition as 32:27. In our group there were 40 males and 36 females. The youngest was 6 months old and the oldest 76 years.

For only 2 of the 76 patients was there any family history of situs inversus. Two men stated that they each had a brother (not a twin) with the same condition. Cockayne maintained that transposition of the viscera is caused by a single mendelian autosomal recessive characteristic. However, Torgersen⁹ found only 6 instances of the condition in 573 siblings of patients with complete situs inversus. If a mendelian recessive characteristic had been present, the expected incidence would have been 1 in 3 and not 6 in 573. According to Torgersen, there have been 6 instances in which transposition occurred in 3 siblings and 19 instances in which the condition occurred in 2 siblings. Only 1 instance has been reported in which both mother and daughter were so affected.

Cleveland lists three theories as to the cause of the condition: 1. It results from the fact that persistence of a right omphalomesenteric vein has influenced the shifting of the stomach to the right instead of to the left. 2. It is due to the influence of the umbilical cord. In situs inversus, the cord is wound spirally to the right instead of to the left. According to this theory, the fact that the blood column flows in a different direction is responsible for the turning of the heart to the opposite side. 3. The condition is the result of the turning of the embryo to the right side of the umbilical vessels instead of to the left, as it normally lies.

A more complete review of the theories as to the cause of situs inversus is given by Wood and Blalock,¹⁰ Adams and Churchill⁴ and

6. Cleveland, M.: Situs Inversus Viscerum: An Anatomic Study, Arch. Surg. **13**:343-368 (Sept.) 1926.

7. Rösler, H.: Beiträge zur Lehre von den angeborenen Herzfehlern: VI. Ueber die angeborene isolierte Rechtslage des Herzens, Wien. Arch. f. inn. Med. **19**:505-610, 1929-1930.

8. Cockayne, E. A.: The Genetics of Transposition of the Viscera, Quart. J. Med. **7**:479-493 (July) 1938.

9. Torgersen, J.: Familial Transposition of Viscera, with Preliminary Remarks on Genetics and the Correlation with Diseases of the Respiratory Tract, Acta med. Scandinav. **126**:319-322, 1946.

10. Wood, G. O., and Blalock, A.: Situs Inversus Totalis and Diseases of the Biliary Tract: Survey of the Literature and Report of a Case, Arch. Surg. **40**:885-896 (May) 1940.

Jordan and Kindred.¹¹ It is believed that there are two types of persons with transposition of the viscera. The first type is that of a completely normal mutant and the second that of a true monster in whom other stigmas of maldevelopment may be anticipated.

Since Siewert¹² in 1904 reported the first case of what has since been called "Kartagener's syndrome," it has been known that the incidence of bronchiectasis and sinusitis in patients with complete situs inversus is greater than that noted in the general population. In 1933 Kartagener reported on 4 patients who had the triad of situs inversus, sinusitis and bronchiectasis. In 1935 he¹³ reported 6 additional cases of the syndrome to which his name has been given.

In 1937 Adams and Churchill, in a study of 23 patients with situs inversus, found that 5, or 21.7 per cent, of the patients had bronchiectasis. The incidence of bronchiectasis in the hospital population is 0.306 per cent.

Fourteen patients at the clinic had all three components of the Kartagener syndrome, namely, situs inversus, bronchiectasis and sinusitis. Three other patients had situs inversus with bronchiectasis alone, making a total of 17 patients who had bronchiectasis of 80 with situs inversus (76 situs inversus totalis and 4 situs inversus thoracis). Four of the 17 had apparently only a thoracic situs inversus. This would give an incidence of bronchiectasis of 21.25 per cent in the patients with situs inversus, a definite increase over the incidence in persons without situs inversus.

Two of the 76 patients with complete situs inversus were found to have active duodenal ulcers on roentgenologic examination. Both patients were treated medically.

Although these patients are few and far between in the general surgeon's experience, it is essential that their existence be kept in mind. Thirty-six of the 76 patients who had a diagnosis of complete situs inversus underwent surgical treatment at the clinic or elsewhere, an incidence of 47 per cent. At least 2 had had incisions made in the right lower quadrant for removal of diseased appendixes, only to have a second incision made on the left side because of the undiagnosed situs inversus. Sixteen of the 76 patients with complete situs inversus underwent appendectomy, of whom 4 were operated on at the clinic and 12 elsewhere.

11. Jordan, H. E., and Kindred, J. E.: *A Textbook of Embryology*, New York, D. Appleton & Company, 1926, pp. 239-241.

12. Siewert, A. K., cited by Adams and Churchill.⁴

13. Kartagener, M.: *Zur Pathogenese der Bronchiektasien; Bronchiektasien bei Situs viscerum inversus*, *Beitr. z. Klin. d. Tuberk.* **83**:489-501, 1933; *Familiäres Vorkommen von Bronchiektasien*, *ibid.* **84**:73-85, 1933; *Situs viscerum inversus und Polyposis nasi in einem Falle familiäres Bronchiektasien*, *ibid.* **87**:331-333, 1935.

Seven of the 76 patients had biliary disease. Two of the 7 were infants who had congenital atresia or obliteration of the bile ducts associated with complete situs inversus. Smyth¹⁴ in 1941 reported the only other case we were able to find of congenital obliteration of the bile ducts associated with total visceral transposition.

The first infant was a boy aged 11 months who was admitted on April 26, 1937, because of persistent jaundice. His delivery had been uncomplicated and at term. The birth weight was 7 pounds and 4 ounces (3.3 Kg.). His parents and 4 siblings were living and well. No situs inversus or other congenital anomaly was noted in them. The jaundice was present at the time of the child's birth, and it became progressively severe during the succeeding eleven months. The stools had been white since birth. The baby nursed poorly and was drowsy and listless all the time. Physical examination at birth showed micrognathia, dextroposition of the heart, transposition of the abdominal viscera and jaundice.

At the age of 2 months the child had had a short episode of fever and vomiting, but a diagnosis had not been made. At that time, marked enlargement of the liver was noted.

Physical examination at the time of his admission at the clinic showed a scrawny icteric male infant who weighed 11½ pounds (5.2 Kg.), as compared with the normal of 20 pounds and 8 ounces (9.3 Kg.). Dextrocardia was noted. The liver was firm and hard, and it extended 2 cm. below the left costal margin. The spleen extended 1 to 2 cm. below the right costal margin.

On May 5, 1937, choledochoduodenostomy was performed at the clinic. A primary incision in the upper part of the left rectus muscle was used. At operation a complete situs inversus of the abdominal viscera was found. The liver was nodular, greenish and about twice the normal size. The gallbladder was rather small and collapsed, and it did not seem to contain any bile. There was congenital atresia of the lower end of the common bile duct. The child died suddenly about twenty-eight hours postoperatively. The necropsy showed cirrhosis of the liver, with congenital atresia of the bile ducts in an infant with complete situs inversus.

The second infant was a girl aged 6 months who was admitted on July 14, 1947, because of progressive jaundice which had been present since the age of 9 days. Her delivery had been uncomplicated and was at term. Her parents, her 6 siblings and other members of the family did not have situs inversus or any other congenital anomaly.

On July 22, 1947, an operation was performed at the clinic. Through a primary incision in the upper part of the left rectus muscle the liver was found to be completely on the left side of the abdomen. It was grossly cirrhotic, and microscopic examination of hepatic tissue showed chronic hepatitis and fibrosis. No evidence of a gallbladder or of any extrahepatic or common bile duct system was found. A diagnosis was made of congenital atresia of the intrahepatic and extrahepatic biliary duct system. The incision was closed after further exploration of the abdomen revealed the situs inversus to be complete. The child had an uneventful postoperative course and was dismissed on Aug. 2, 1947, the eleventh postoperative day. We have not heard from her parents since her dismissal.

14. Smyth, M. J.: Congenital Obliteration of Bile Ducts with Total Transposition of Viscera, *Brit. M. J.* 1:84-85 (Jan. 18) 1941.

In 1940 Wood and Blalock found records in the literature of 17 cases of situs inversus totalis associated with disease of the biliary tract. They reported 1 of their own. In 1942 Metheny, Sherwood and Zimmerman¹⁵ added a case.

Five of the 76 patients reported on here had had a diagnosis of cholecystitis and cholelithiasis. Two of the 5 had undergone cholecystectomy elsewhere prior to their registration at the clinic.

The first patient was a housewife aged 35 years who came to the clinic in 1918 because of a small dermoid cyst on the right brow. Her cholecystectomy was reported on by Hupp¹⁶ in 1911. She stated that she had had no further abdominal complaints after her operation, at which complete transposition of the abdominal viscera had been found.

The second patient was a housewife aged 48 years who had had a cholecystostomy performed elsewhere in 1927. At that time a complete transposition of the abdominal viscera was found. She came to the clinic because of jaundice but refused further surgical treatment. She has not answered letters of inquiry as to her progress. To the best of our knowledge, this case has not been reported.

Three patients had a diagnosis of cholecystitis and cholelithiasis made at the clinic.

A retired farmer of Swedish descent, aged 59 years, came to the clinic on March 16, 1942, for a general examination. In 1934 an incision had been made on the right side of his abdomen because of the diagnosis of appendicitis, made elsewhere. No appendix was found. In 1936, as a result of a continuation of the attacks of appendicitis, an incision was made, also elsewhere, on the left side of the abdomen and he had undergone appendectomy. At that time, situs inversus of the abdominal viscera was found. He stated that his health had been good since his operation but that for the past two years he had noted that fatty foods caused "gas." His family history did not reveal situs inversus or any other congenital anomaly. Physical examination showed an essentially normal condition except for the scars of the operation mentioned previously and bilateral inguinal hernias. Roentgen examination showed dextrocardia and situs inversus of the colon. The roentgenogram of the abdomen showed, in the left upper quadrant, a shadow which was believed to be a stone in the gallbladder. Surgical treatment was not advised, and the patient was dismissed on March 7, 1942.

The second patient with complete situs inversus for whom the diagnosis of cholecystitis and cholelithiasis was made at the clinic was reported on by Counseller¹⁷ in 1931. We wish to report on the third

15. Metheny, D.; Sherwood, K. K., and Zimmerman, B.: Complete Situs Inversus Associated with Cholelithiasis, *West. J. Surg.* **50**:254-257 (May) 1942.

16. Hupp, F. L.: Malpositions of the Liver, *New York State J. Med.* **94**:422-426 (Aug. 26) 1911.

17. Counseller, V. S.: Rupture of the Spleen: Gunshot Wounds of the Abdomen; Transposition of Organs; Report of Cases, *Proc. Staff Meet., Mayo Clin.* **6**:501-505 (Aug. 26) 1931.

patient with that diagnosis at the clinic, who was the second to undergo cholecystectomy.

The patient was a Jewish housewife aged 46 years who had been born in Russia. As far as she knew, no other members of her family had had situs inversus or any other congenital anomaly. In 1934 appendectomy and suspension of the uterus had been done elsewhere. At that time transposition of all the abdominal viscera was found. Except for this, her history had been uneventful until about six months before registration at the clinic on May 24, 1948. Then she noted dyspepsia caused by ingestion of fatty food and the onset of attacks of epigastric pain which extended through to the back. These attacks occurred two to three times a week and at one time required a hypodermic injection of morphine for their relief. She never had been jaundiced. The previous diagnosis of complete situs inversus was confirmed by physical examination, which otherwise revealed nothing remarkable. The roentgenologic examination showed dextrocardia and a functioning gallbladder that contained multiple stones. The gallbladder was in the left upper quadrant of the abdomen. The laboratory examination of the blood and urine gave essentially negative results. Because of the history and findings, surgical treatment was advised. On May 29, 1948, one of us (C. W. M.) performed cholecystectomy and oophorectomy on the right side, utilizing an incision retracting the upper part of the left rectus muscle. All the organs in the abdominal cavity were found to be reversed. The stomach was on the right side and the gallbladder and liver on the left side. The liver was sharp edged. The stomach and pylorus were normal. The common bile duct was exposed down to the cystic duct, and the gallbladder was removed after a double tie had been placed on the cystic duct. The gallbladder fossa was closed. Exploration of the pelvis revealed a dermoid cyst of the right ovary, which was removed. The patient had an uneventful postoperative course and was dismissed on June 10, 1948, the thirteenth postoperative day. At that time she stated that she felt well.

SUMMARY AND CONCLUSIONS

Seventy-six of 1,551,047 patients who registered at the Mayo Clinic from 1910 through 1947 were found to have complete (abdominal and thoracic) situs inversus on the basis of physical or roentgenologic observations or both. This represents an incidence of about 1 in 20,000. Forty-seven per cent of these 76 patients underwent surgical treatment at the clinic or elsewhere.

Two cases of congenital atresia of the bile ducts in infants with complete situs inversus are reported.

Five patients with complete situs inversus had had disease of the gallbladder previously or at the time of admission to the clinic. Two of the 5 had undergone cholecystectomy elsewhere; 1 of these was reported on elsewhere. One of the 5 did not have sufficient difficulty to warrant an operation. The other 2 of the 5 patients underwent cholecystectomy at the clinic, 1 of whom has been reported on previously; the other was the basis for a case report that is included here.

The possibility that situs inversus may be present must always be kept in mind by the physician performing abdominal surgery.

DISCUSSION

DR. W. J. POTTS, Chicago: It is well to remember that congenital anomalies are frequently multiple. When an infant or newborn child presents a congenital anomaly which is obviously remediable surgically, one should look for other anomalies. It is embarrassing to correct an anomaly and find that one more serious has been overlooked.

Complete situs inversus is a congenital anomaly, whether it is total or whether it is just of the abdomen. I think that the reason that Dr. Mayo reports only 76 cases from their huge number of admissions is that they see relatively few newborn children. Many of the youngsters with transposition of the organs have other anomalies incompatible with life. During the past year we have seen 4 patients with situs inversus totalis. The first was a child who also had multiple congenital anomalies of the heart, including transposition of the great vessels.

(Slide) This otherwise normal child had just one anomaly—it was a mirror image of itself. It is a 3 month old baby who died about two weeks ago of meningitis. You see the heart on the right side and the gallbladder down on the left. It is a complete situs inversus, and this is the only child who did not have associated anomalies.

(Slide) This 4 month old youngster had complete transposition and exstrophy of the bladder. Besides, there was a prolapse of the rectum present since shortly after birth. Incidentally, we have seen 2 others like this in previous years. In each we have drawn down the prolapsed bowel until it was on slight tension, amputated the protruding portion and done an end to end anastomosis just proximal to the mucocutaneous line. It has been successful in 3 children; in each a competent sphincter has developed. Later the ureters were transplanted in this child.

(Slide) This child is rather unique—an 8 year old girl who was extremely cyanotic and had a tetralogy of Fallot. The heart was on the right side, typically boot shaped. Oddly enough, this child had still another anomaly in that the arch of the aorta was on the left. Of patients with tetralogy of Fallot on whom we have operated, 28 per cent, or 38, have had right aortic arches when the heart was on the left. This child had a mirror image of that—the heart on the right side and the arch of the aorta on the left. A typically aortic-pulmonary anastomosis was successfully done.

Congenital anomalies are multiple. Do not forget it, or you will suffer the same embarrassment which I have experienced.

PREFRONTAL LOBOTOMY IN THE MANAGEMENT OF INTRACTABLE PAIN

COLONEL FRANK E. HAMILTON

AND

MAJOR GEORGE J. HAYES,

MEDICAL CORPS, UNITED STATES ARMY

ON OCCASION pain is a useful thing. It may aid in achieving a diagnosis or it may merely bring a patient to a physician so that his ill may be diagnosed. Our purpose is not to talk about such pain but rather to discuss a treatment for pain which results from carcinoma, causalgia or some other condition in which the pain is serving no useful purpose. There are various methods of treating such pain; opiates, sedatives, alcohol injection, neurectomy, rhizotomy and cordotomy all have their place, but in certain cases none of these may achieve the desired result. Prefrontal lobotomy, originally used for psychosis, has been proposed¹ and used by a number of persons faced with this problem. Freeman and Watts² first used prefrontal lobotomy for pain associated with involutional depression in 1936 and have since then performed it on approximately 25 patients having pain of solely organic nature. Mason and Hamby³ described a case of paraplegia associated with morphine addiction in which prefrontal lobotomy relieved the pain as well as the addiction, with no evidence of symptoms of morphine withdrawal. Similar encouraging experiences have been had by others⁴ using this method (fig. 1). The close association with Dr. Watts, a consultant to the Neurosurgical Section at Walter Reed General Hospital, and the previous experience of one

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 2, 1948.

1. White, J. C.: Pain After Amputation and Its Treatment, *J. A. M. A.* **124**:1030 (April 8) 1944. Walker, A. E.: Central Representation of Pain, *A. Research Nerv. & Ment. Dis., Proc.* **23**:63, 1943.

2. Freeman, W., and Watts, J. W.: Pain of Organic Disease Relieved by Prefrontal Lobotomy, *Lancet* **1**:953, 1946.

3. Mason, T. H., and Hamby, W. B.: Relief of Morphine Addiction by Prefrontal Lobotomy, *J. A. M. A.* **136**:1039 (April 17) 1948.

4. Van Wagenen, W. P.: Unpublished data, cited by Walker, A. E.: Central Representation of Pain, *A. Research Nerv. & Ment. Dis., Proc.* **23**:63, 1943. Poppen, J. L.: Prefrontal Lobotomy for Intractable Pain: Case Report, *Lahey Clin. Bull.* **4**:205, 1946. Horrax, G.: Experiences with Cortical Excisions for the Relief of Intractable Pain in the Extremities, *Surgery* **21**:593, 1946.

of us under the guidance of Dr. Poppen stimulated interest in using prefrontal lobotomy for pain of organic nature not amenable to other modes of therapy. There are three generally accepted methods of performing prefrontal lobotomy in use commonly today. Unilateral lobotomy has been done; as yet we have had no experience with it.

The first method is the classic procedure of Freeman and Watts. The orientation point is the pterion; a perforation is made approximately 2 cm. or less in diameter. A leukotome is introduced, and by means of a vertical sweeping cut and then by radial stabs the frontothalamic pathways are severed. The plane of incision is roughly shown (fig. 2). The path of the blade may be visualized by means of iodized poppyseed oil placed in the tract of section (fig. 3). The plane of section lies posterior to the crista Sylvia and makes an obtuse angle with the floor of the frontal fossa.

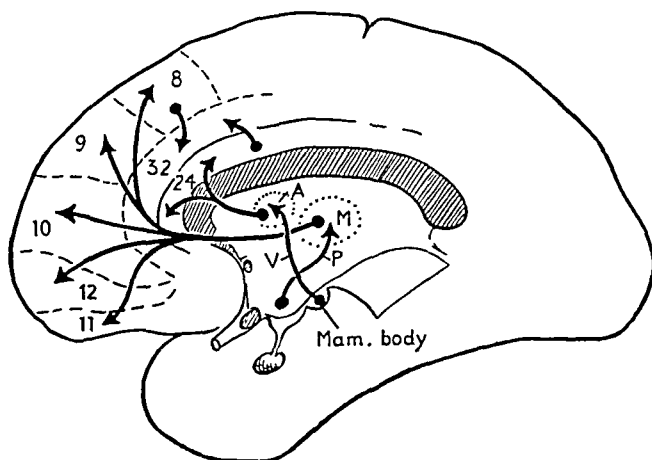


Fig. 1.—Frontal thalamic pathways, the section of which is of apparent importance for the relief of intractable pain. (Le Gross Clark, W. E.: *The Connexion of the Frontal Lobes of the Brain*, *Lancet* 1:6497, 1948.)

Recently Freeman⁵ has introduced the procedure of transorbital lobotomy. This was first described by Fiamberti, of Italy, who injected alcohol or solution of formaldehyde into the frontal lobes. A stainless steel stylus is introduced across the orbit, punctures the roof of the orbit, enters the inferior aspect of the frontal lobes and is swept transversely to sever the fiber tracts (fig. 4).

The Lyerly technic with modification was used most commonly in our cases. Two and one-half centimeter buttons are removed 4 to 5 cm. lateral to the midline from the frontal bone anterior to the coronal suture. Originally the Lyerly technic based these trephine openings at the coronal suture. We have found, in accord with the observation

5. Freeman, W.: Personal communication to the authors.

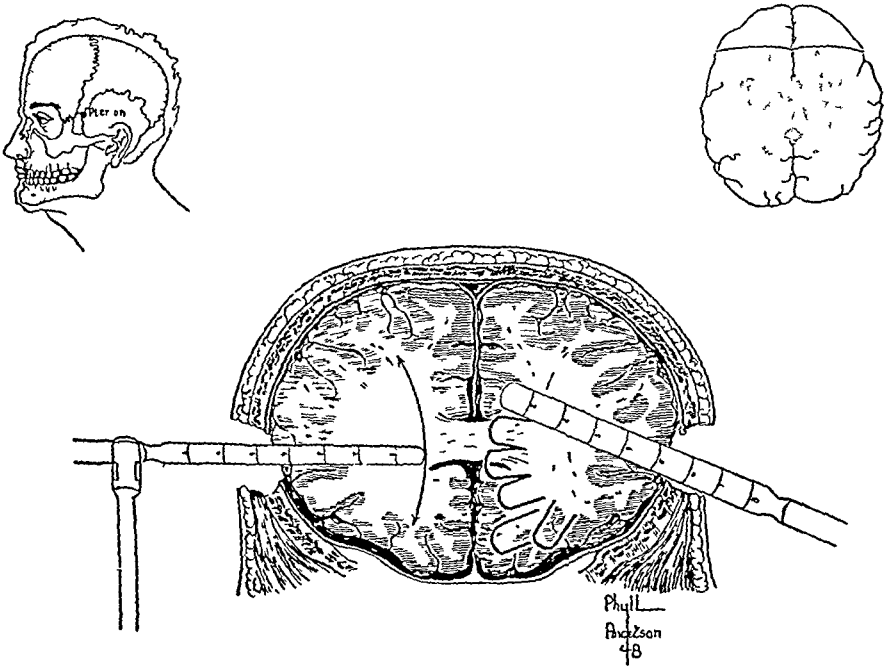


Fig. 2.—The classic method of Freeman and Watts for severing the myelinated tissue of the frontal pole.



Fig. 3.—Iodized poppyseed oil in the plane of section following lobotomy by the technic of Freeman and Watts.

of Otenasek⁶ that we can with advantage move the plane of section somewhat forward. A core of cortical and myelinated tissue is removed by suction and cautery, then lateral cuts and stabs are made with a spatula cutting the fiber pathways (fig. 5).

The resultant plane of section is possibly somewhat anterior to the crista Sylvia and is almost perpendicular to the plane of the frontal

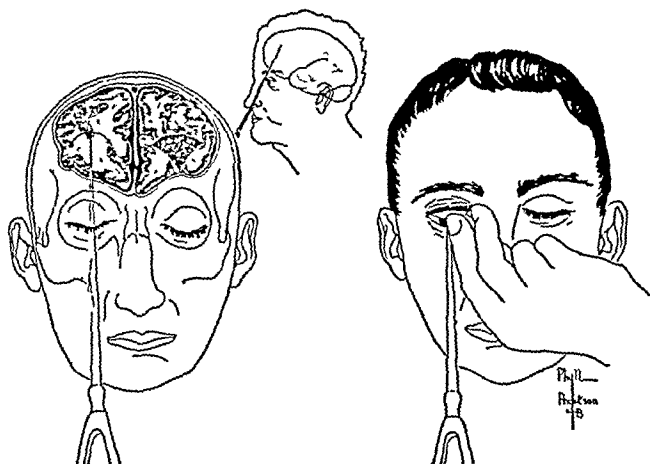


Fig. 4.—Transorbital lobotomy with the indicated plane of section and amount of tissue severed.

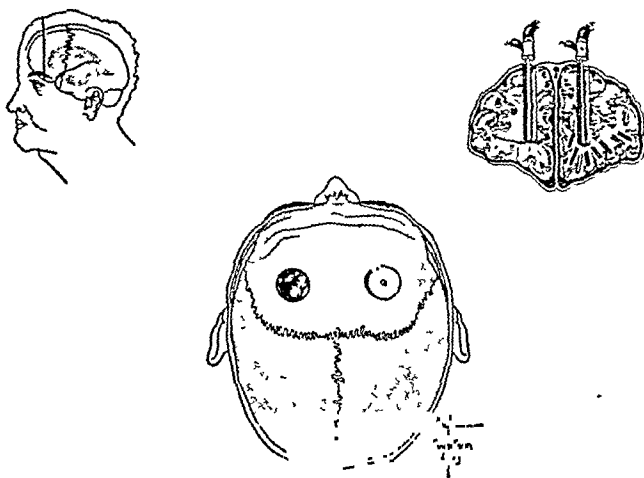


Fig. 5.—Lyster technique for lobotomy modified by moving the plane of section forward and making it more perpendicular to the plane of the orbital cortex.

fossa (fig. 6). All operations are performed under local anesthesia. During the procedure a battery of questions is asked by an assistant to evaluate the responses for factual accuracy as well as for changes

6. Otenasek, F. J.: Prefrontal Lobotomy for the Relief of Intractable Pain. *Bull. Johns Hopkins Hosp.* 83:229, 1948.

in voice modulation, which is a reflection of emotional overtone. The section of fiber pathways is stopped when one of two factors supervenes, i.e., either slight disorientation or an appreciable flattening in the voice tone. Usually when either of these occurs the patient ceases spontaneously to complain of pain.

We have had in all 16 patients (table 1). There have been 3 deaths (18 per cent) directly associated with surgical treatment, 1 due to hemorrhage five days postoperatively, 1 following convulsion occurring at operation, the reason for which has never been clearly ascertained, and the last from a self-inflicted infection of the lobotomy incision with brain abscess and meningitis. The reactions following surgical intervention for previously disabling pain as observed in this series range

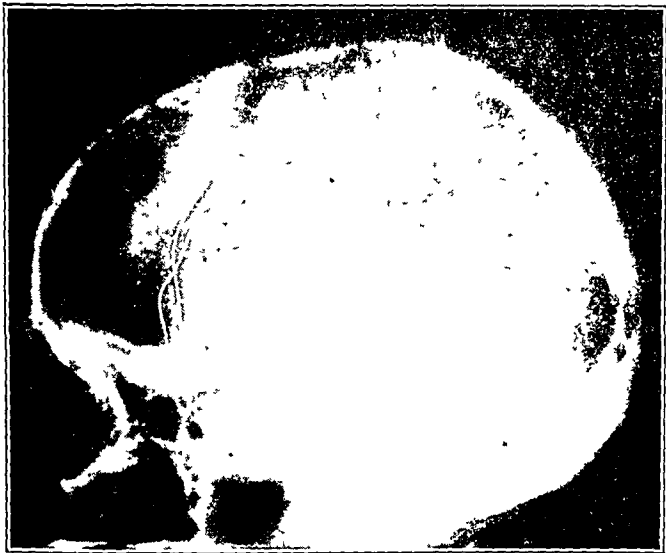


Fig. 6.—Tantalum wires placed in the plane of section showing modified Lyster technic.

TABLE 1.—Cause of Pain

Carcinoma.....	10
Painful phantom limb.....	3
Causalgia.....	1
Quadruplegic spasm.....	1
Tabetic crisis.....	1

from complete denial of pain to no admission of benefit. The intermediate levels are (a) affirmative statements of pain on direct questioning but absence of any spontaneous complaint referable to it, (b) occasional complaints of pain made spontaneously but with no apparent real distress requiring medication and (c) a lowering of the preoperative

general distress, with a lessened but continued need for medication. These have been graded 4 plus for denial of pain to zero for no benefit (table 2).

An important item for consideration is the social status of the patient. This embraces his reaction to the persons around him in or out of a hospital environment. The desirable goal is a person who is essentially unchanged. This cannot always be achieved, especially in the immediate postoperative phase. However, with the passage of time the social adjustment of the disoriented patient improves usually to a level at which adequate adjustment in a home or hospital environment is possible (table 3).

TABLE 2.—*Relief of Pain**

4 Plus	3 Plus	2 Plus	1 Plus	0
5	7	1	1	1

* In this computation 1 postoperative death is not included.

TABLE 3.—*Social Adjustment After Lobotomy*

Social Recovery *	
Excellent 6	Good 7
Time Required	
Excellent Minimum, 1 day Maximum, 2 mo.	Good Minimum, 2 wk. Maximum, 3 mo.

* Three postoperative deaths are not included.

COMMENT

The exact mechanism for the relief obtained after lobotomy is not certain. It has been postulated that dissociation occurs, separating the emotional reaction to pain from the more physiologic stimulus of pain. This may be exemplified by patients who still experience pain yet show no distress because of it. However, there are patients who after lobotomy constantly deny the existence of pain of the type which was present prior to operation. All these patients react to acute pain such as pinprick and removal of sutures in a normal or even hyperactive manner. The question of the plane of section in relation to the tip of the frontal horns is one which has been of pertinent interest to us, inasmuch as the farther forward from the frontal horns one is able to establish the plane of section, the less severe is the disorientation and the less prolonged the social rehabilitation of the patient. We have been successful with a plane of section anterior, by at least 1 cm., to the tips of the frontal horns.

The face of each frontal pole as seen after coronal section may be divided into four quadrants—the upper medial and lateral and the lower medial and lateral. There is some question of the necessity of dividing the fiber tracts from all four quadrants of each frontal pole. Approximately half of our patients have had satisfactory result from section of only both lower quadrants bilaterally or from section of both lower quadrants bilaterally with section of only the medial quadrants superiorly. This indication that the lower quadrants are more closely associated with the relief of pain than the upper quadrants is in accord with observations of Watts⁷ and Koskoff.⁸ It is not possible to say definitely that section of only lower quadrants will achieve the desired result, but at least it does seem that it is necessary to sever the pathways in the lower quadrants for relief of pain.

Relationship of the amount of relief from pain to social acceptability does not seem to be constant. There are patients who deny pain which was previously present but who show social aberration after lobotomy.

TABLE 4.—*Symptoms of Morphine Withdrawal*

	Patients
Total patients.....	16
Morphine users.....	12
Showed withdrawal signs.....	9
Showed no withdrawal signs.....	3
Died two days postoperatively.....	1

There are other patients who still complain of pain, even with some sign of emotional distress related to it, who have rather notable disorientation. At this time it is impossible to make a close correlation between these two factors. It has been our impression, however, that by moving the plane of section forward and by making it as nearly as possible perpendicular to the frontal fossa, social disorientation is reduced while relief from pain is maintained at a satisfactory level. This is in agreement with the findings of Otenasek.⁶

The effect on morphine addiction as far as physiologic manifestations are concerned in our series is at variance with the findings of Mason and Hamby.³ The majority of our patients who had been forced to use large amounts of morphine for prolonged periods (often as much as $\frac{1}{4}$ to $\frac{1}{2}$ grain [15 to 30 mg.] every one and a half to two hours) showed tremor, sweating and diarrhea in the first days after operation. Some were given no morphine, and it was observed that these signs

7. Watts, J. W.: Personal communication to the author.

8. Koskoff, Y. D.; Dennis, W.; Lazovik, D., and Wheeler, E. T.: The Psychological Effects of Frontal Lobotomy Performed for the Alleviation of Pain, *A. Research Nerv. & Ment. Dis., Proc.* 27:723, 1948.

gradually disappeared over a period of four to five days. Others were given morphine after the signs had become established, with immediate cessation of the signs of morphine withdrawal, no recurrence and a gradually diminishing physiologic need for morphine. None of the patients who showed withdrawal signs complained of discomfort related to those signs, nor did they ask for morphine to alleviate them. Apparently the older concept of psychic and physiologic addiction to morphine still holds true.

We wish to make clear that, while we consider lobotomy a useful procedure in certain circumstances, we do not feel that it should be used indiscriminately for pain as a symptom. Although great care is taken to avoid so much of a section as to render the patient permanently or for a long time incapable of social rehabilitation or so little of a section as not to relieve his pain, because of the variability of the landmarks used in determining the plane of section this is not always possible.

DISCUSSION

DR. W. P. RITCHIE, St. Paul: My experience has been limited to only 5 cases, 4 with excellent results and 1 with a fair result.

It is evident to me that one must temper one's enthusiasm for this procedure by a most careful evaluation of the type of person, particularly if he is nonpsychotic. This was rather forcefully brought to my attention when the opportunity presented itself to perform a prefrontal lobotomy for pain on a close relative of mine who had metastatic carcinoma of the spine. This man had always been a valued member of his community. His intellectual ability was high, and he was greatly respected. In spite of my enthusiasm for this procedure there was no question in my mind, and also no question in the family's mind when it was explained to them, that it would be wrong to take any chance of impairing this man's intellect and his value to his community. If he had nothing to offer to his community it certainly would have been done; he still is an active man in spite of his pain.

Bilateral prefrontal lobotomy is not without its unmixed blessings, and I think everyone who performs this procedure feels that it never should be performed unless life has become unbearable and all other methods for the relief of the trouble have been exhausted.

MAJOR GEORGE J. HAYES, Washington, D. C.: Dr. Ritchie has put his finger on the important point in the use of lobotomy for the treatment of pain. We do not feel (and I emphasize what I said before) that it should be used indiscriminately. It has so many variables that one cannot accurately predict what the result will be.

The only thing we can say is that, from the more recent cases of our series, with the change in the plane of section establishing it a little forward of the frontal horns and making it more perpendicular to the floor of the frontal fossa, the social disorientation lasts for a much shorter time and may not even be present. Our last patient was never disoriented and completely denied pain. In no circumstances would I say that we can guarantee what the result is going to be in any given operation. Our feeling is that this is a procedure which is worthy of development to determine of how much value it is going to be to the general practitioner who is faced with the problem of pain.

SURGICAL MANAGEMENT OF INSTRUMENTAL PERFORATION OF THE ESOPHAGUS

J. DEWEY BISGARD, M.D.

AND

H. HARPER KERR, M.D.

OMAHA

PERFORATION of the esophagus from instrumentation is a tragic accident and an urgent surgical emergency. Unless promptly and properly treated, it is usually fatal. Proper treatment consists of the immediate establishment of wide and free drainage to the site of perforation in addition to adequate antibiotic and supportive therapy and other less important measures. This has been emphasized by Hoover,¹ Touroff² and others.

Although this discussion is concerned with perforation caused by instrumentation, it would seem desirable to include a classification of all causes.

A. Intrinsic causes

1. Tumors arising in the oesophagus
2. Esophagitis
Nonspecific, tuberculous, syphilitic
3. Spontaneous perforations
Ruptures from violent vomiting
4. Ulceration
Peptic, Curling's (Rankin)³

B. Extrinsic causes

1. Instrumentation
Endoscopy, dilation
2. Swallowed foreign bodies
Bones, dentures, pins
3. Penetrating wounds
Stab, bullet
4. Penetration of extrinsic neoplasms

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 2, 1948.

1. Hoover, W. B.: Mediastinitis as a Complication of Esophagoscopy and Instrumentation of the Esophagus, *S. Clin. North America* **25**:575-578, 1944.

2. Touroff, A. S. W., and others: Perforation of the Cervical Esophagus with the Flexible Gastroscope: Case Report, *Ann. Surg.* **114**:369-374, 1941.

3. Rankin, L. M.: Perforated Ulcer of the Esophagus Following a Burn, *Am. J. Surg.* **67**:134-136, 1945.

5. Perforations of extrinsic infections

Pyogenic and tuberculous adenitis and mediastinal abscesses

6. Aortic aneurysm

7. Ulceration due to swallowed caustics and indwelling gastric tubes (Hayes) ⁴

From a clinical point of view these etiologic factors may be grouped under the following headings.

1. Slowly perforating lesions, erosion of tumors and some foreign bodies
2. Minute perforations, as those by pins and fish bones
3. Gross immediate perforations, from instrumentation, penetrating wounds and spontaneous rupture during vomiting

In the first two groups there is an opportunity for walling off the involved area before perforation takes place so that soiling and infection remain localized or spread slowly in the majority of cases. It is in this group that cures have followed either conservative management or late drainage of localized abscesses, and, unfortunately, the reported successes in these cases have been misinterpreted as evidence in support of conservative management of all types of perforation.

In the third group gross soiling takes place immediately and within a few hours infection may extend throughout the involved spaces, in perforations of the proximal portion of the esophagus throughout the entire retrovisceral space and superior mediastinum, an area extending from the occiput to the bifurcation of the trachea, and in perforations of the distal half of the organ the posterior mediastinum and not infrequently one or both pleural cavities. This rapid and extensive spread of infection is favored by several factors. First, the retrovisceral space and the mediastinum contain no tissue barriers except loose areolar tissue and the retrovisceral space communicates with the superior mediastinum with no more than an area of narrowing at the thoracic inlet to impede the spread. The indirect communication between the superior and posterior mediastinums at the root of the lungs appears to be a more effective barrier. Immediately after perforation swallowed air is forced through the rent and quickly inflates the spaces so that they are open to the more or less free passage of bacteria-laden saliva. The esophagus always harbors a rich flora of pathogens. Furthermore, it would seem plausible that during the negative phases of intrathoracic pressure in inspiration the contents of the retrovisceral space and those of the esophagus itself are aspirated into the mediastinum. Also the movement of the esophagus in the act of swallowing and the constant motion of the lungs, heart and great vessels discourage the formation of a limiting plastic membrane and otherwise contribute to the spread of infection.

4. Hayes, J. M.: Esophageal Perforation from a Stomach Tube, *Minnesota Med.* **25**:280 and 306, 1942.

In most of the reported cases of spontaneous perforation of the esophagus, symptoms of rupture have developed after the vomiting of a large meal and at operation or autopsy considerable gastric contents including food have been found in the mediastinum. For more information about this interesting cause of rupture and of perforations resulting from gunshot wounds and other forms of external violence the reader is referred to the publications of Kinsella and others,⁵ Sommer and others,⁶ Barrett,⁷ Collis and his associates⁸ and Eliason and Welty.⁹ These two types have in common with instrumental perforations certain characteristic signs and symptoms which if recognized will lead to an early diagnosis. In the case of spontaneous rupture, an antemortem diagnosis has been made in only a few instances and then by surgeons who have learned from a past experience the characteristic syndrome. Sudden perforations from any cause promptly give rise to pain which at first is located in the region of the perforation but spreads early and usually becomes severe. Swallowing and respiratory movements increase the pain. In patients with perforations of the distal end of the esophagus shock and cyanosis soon develop, with rapid, shallow, grunting respiration, and they complain with much anxiety that they are "unable to breathe" or tolerate the pain. Usually within a few hours there is a sharp rise in the pulse rate and temperature and not infrequently a chill. Also within minutes or a few hours air appears in the tissues and disseminates and increases rapidly so that subcutaneous emphysema may be demonstrable in the neck within minutes after perforation of the cervical portion of the esophagus and a few hours after perforation of the distal end. The severity, location and progressive diffusion of pain should give rise to a suspicion of a perforation, and the demonstration of air in the tissues either by palpation or in roentgenograms in the absence of the other obvious causes of interstitial emphysema confirms the diagnosis. As pointed out by McGibbon and Mather,¹⁰ the roentgenologic findings in perforation of the cervical portion of the esophagus are rather typical. Early there is the mottling of small areas of lesser density of air scattered in a shadow of tissue

5. Kinsella, T. J.; Morse, R. W., and Hertzog, A. J.: Spontaneous Rupture of the Esophagus, *J. Thoracic Surg.* **17**:613-631, 1948.

6. Sommer, G. N. J., and O'Brien, C. E.: War Wounds of the Esophagus, *J. Thoracic Surg.* **17**:393-400, 1948.

7. Barrett, N. R.: Spontaneous Perforation of the Oesophagus, *Thorax* **1**:48-70, 1946.

8. Collis, J. L.; Humphreys, D. R., and Bond, W. H.: Spontaneous Rupture of the Esophagus, *Lancet* **2**:179, 1944.

9. Eliason, E. L., and Welty, R. F.: Spontaneous Rupture of the Esophagus, *Surg., Gynec. & Obst.* **83**:234-238, 1946.

10. McGibbon, J. E. G., and Mather, J. H.: Perforation of the Oesophagus by Swallowed Foreign Bodies, with Radiological Notes, *Lancet* **2**:593-597, 1935.

density occupying the retrovisceral space more or less completely. Air is also visible in the planes of the neck extending laterally. The pharynx is compressed and the esophagus displaced forward, with widening of the space between them and the vertebral bodies. Subsequently the locules of air may coalesce and, with the development of fluid, present fluid levels.

Involvement of the mediastinum is indicated by an increase in their widths, as outlined early by the lesser density of air and later by the dense shadow of edema and fluid. In the case of instrumental perforations, the diagnosis is simplified by the knowledge or suspicion of injury as observed by the endoscopist or by the recent history of instrumentation.

Instrumental perforations occur most frequently during esophagoscopy. The esophagus may be torn in the process of passing the esophagoscope (cases 1 and 2), particularly at the levels of narrowing, the so-called cricopharyngeal pinchcock and the cardia or in the process of removing a foreign body (case 3) or of a biopsy. Curiously enough, the instrument responsible for the next largest number of cases, as judged from case reports in the literature¹¹ of the past ten years, is the gastroscope. This is of particular interest in that gastroscopy is considered a simple and safe diagnostic procedure. Perforations with this instrument have occurred principally at the two levels mentioned previously. Ruptures from dilation of strictures (case 4) and of the cardiac sphincter are third in frequency. Aside from these, there are reported only a few instances of such unusual causes as self-inflicted injuries¹² (case 5) and 1 instance of perforation during the passing of a stomach tube.

The mortality, as in the case of sudden perforation of the bowel, tends to vary inversely with the time that elapses prior to surgical intervention. If the endoscopist sees a gross perforation from a foreign body or has the misfortune to tear the wall with his instrument, he should not await confirmatory evidence in the way of signs and symptoms with the exception of a roentgenogram taken immediately. Similarly, if a surgeon suspects that a perforation or a rupture has occurred during dilation of the cardia or a stricture, there should be no delay in investigating the possibility by means of roentgenography and esophagoscopy.

11. Fletcher, C. M., and Jones, F. S.: The Risks of Gastroscopy with a Flexible Gastroscope, *Brit. M. J.* **2**:421-422, 1945. Paul, W. D., and Antes, E. H.: Perforation of the Esophagus Caused by a Flexible Gastroscope, *Rev. Gastroenterol.* **13**:23-25, 1946. Paul, W. D., and Lage, R. H.: Perforation of Esophagus Caused by Flexible Gastroscope, *J. A. M. A.* **122**:596 (June 26) 1943. Pembleton, W. E.: Tension Pneumothorax from Rupture of the Esophagus, *Virginia M. Monthly* **73**:331, 1946.

12. King, J. M., and Strus, G. D.: External Perforation of the Esophagus, *Am. J. Surg.* **58**:448-449, 1942.

Surgical management consists of the immediate treatment of shock, if it exists, followed as soon as the patient's condition permits by exposure of the site of perforation and the establishment of a type of drainage which not only will adequately decompress the contaminated space but also will assure the free escape to the surface of the air and fluids that may subsequently leak from the area of perforation. This requirement is met most successfully by means of continuous suction through a sump type of drain, particularly in the cases of perforation of the thoracic esophagus. The cervical portion of the esophagus is exposed through an incision along the anterior border of the sternocleidomastoid muscle on one or both sides (if only one, preferably the left). If a rigid type of drainage tube is used, it must not contact the carotid artery. Hemorrhage from erosion of the artery by this means has been reported. As has been pointed out by Philips¹³ and Wolcott¹⁴ and others, drainage of both the retrovisceral space and the superior mediastinum can be accomplished through the cervical approach, but on occasion a dorsal mediastinotomy may be preferable for drainage of the superior mediastinum. The posterior mediastinum is approached perivertebrally through a lower dorsal mediastinotomy or, in the case of involvement of the pleural cavity, transpleurally through a thoracotomy. It is desirable to close the hole in the esophagus with sutures despite the fact that it usually reopens. Even temporary stoppage of the leak is beneficial.

Large doses of penicillin and streptomycin should be given immediately and continued for several days. There should be nothing taken by mouth for a week or more, that is, until the perforation is completely or at least partially closed and a securely walled-off sinus tract established. Water balance and nutrition may be maintained through a Levin tube threaded past the perforation and into the stomach at the time of operation or by intravenous administration. The benefit of gravity should be taken advantage of. In cases of perforation of the cervical portion of the esophagus the head down position is maintained and in cases of tears of the thoracic portion a sitting posture.

There is usually an esophageal fistula which closes rather promptly, and healing usually takes place without stricture. In 2 of our cases follow-up studies demonstrated the presence of diverticuli one of which may have resulted from the injury but cannot be definitely attributed to it in the absence of previous esophagrams.

The 5 cases which form the basis of this report may be summarized as follows. In 3 cases the perforation involved the cervical portion of the esophagus. Perforations occurred in all during esophagoscopy, in 2

13. Philips, C. E.: Mediastinal Infections from Esophageal Perforations, *J. A. M. A.* **111**:998-1004 (Sept. 10) 1938.

14. Wolcott, C. C.: Periesophagitis, *Laryngoscope* **57**:45-56, 1940.

accidentally in the process of introducing the instrument and in the other one during an unsuccessful effort to remove a foreign body. In all 3 cases the endoscopist was immediately aware of the accident, but in only 1 was surgical drainage promptly established, and this patient recovered. The other 2 patients died, 1 without the benefit of surgical intervention and 1 after drainage and a tracheotomy performed after two days of conservative treatment.

In both cases in which the thoracic end of the esophagus was perforated the underlying lesion was a lye stricture. In 1 patient, a child, perforation was produced by a bougie and in the other by a rather unique type of instrumentation. This patient, a middle-aged woman, learned to use a catheter stretched over a wire stilet to push food past the area of stricture, and on the occasion which led to hospitalization she had forced it through the wall of the esophagus. She recovered with conservative therapy. In the child empyema developed after several critical days from rupture of the mediastinal abscess into the pleural cavity. Drainage of the empyema and gastrostomy for feeding and subsequent retrograde dilation resulted in a cure.

REPORT OF CASES

CASE 1.—K. T., a white woman of 54, entered the Bishop Clarkson Hospital as an outpatient on Oct. 17, 1947, for esophagoscopy investigation of increasing dysphagia of six months' duration. As the esophagoscope passed just beyond the level of the cricoid cartilage, a tear in the posterior wall was observed. The instrument was immediately withdrawn and the patient sent to the x-ray department. Roentgenograms (fig. 1) demonstrated interstitial emphysema of the tissues of the neck, with displacement forward of the esophagus by air in the retrovisceral space.

Within one hour the patient complained bitterly of pain extending from the base of the neck to the occiput and stated that it was made worse with swallowing and on inspiration.

Five hours after the accident drainage was established through an incision along the anterior border of the left sternocleidomastoid muscle. Infiltration anesthesia with procaine hydrochloride was used. The periesophageal tissues contained some air and blood and considerable edema, and in the posterior wall of the esophagus there was a transverse tear 1 cm. long. This was closed with interrupted sutures of 000 chromic surgical gut, and two soft rubber cigaret drains were placed and the wound left wide open. One drain was directed through the thoracic inlet into the superior mediastinum.

Convalescence was essentially uneventful. There was much substernal and interscapular pain and a febrile course for nine days, with a maximum temperature of 102 F. on the fourth and fifth days. For seven days all fluids and nutriment were administered intravenously and 1,200,000 units of penicillin were given daily.

On the eighth postoperative day the drains were removed and liquids were given by mouth and on the following day a soft diet. For three days there was some leakage through the wound and then the fistula closed permanently. Two months after the wound had healed the patient still complained of some "sticking of food" in the neck, and roentgenologic studies of the esophagus revealed a small pharyngeal-esophageal diverticulum.

Comment.—Undoubtedly, early decompression and drainage combined with vigorous antibiotic therapy were responsible for a cure in this case. The finding of an esophageal diverticulum in the follow-up roentgenograms raised the question whether the diverticulum existed prior to esophagoscopy and caused the original symptom of dysphagia or whether it developed from the injury.

CASE 2.—W. S., a white man aged 35, was admitted to the Nebraska Methodist Hospital on Dec. 8, 1942, for the relief of dysphagia of one year. For one week all solid food seemed to stick in the distal end of the esophagus and caused distress until it was vomited. Physical examination and routine laboratory studies revealed no abnormal findings. Barium taken by mouth showed pronounced spasm of the distal end of the esophagus, with considerable delay of the barium in entering the stomach. There was no dilatation, irregularity or filling defect discerned in the esophagus, and the stomach and duodenum appeared to be normal.

An esophagoscopic examination was undertaken, but the patient was tense and did not cooperate well. Resistance was encountered at the level of the cricoid, and the obturator was inserted in an effort to guide the esophagoscope past the point of resistance. The endoscopist then observed a perforation in the

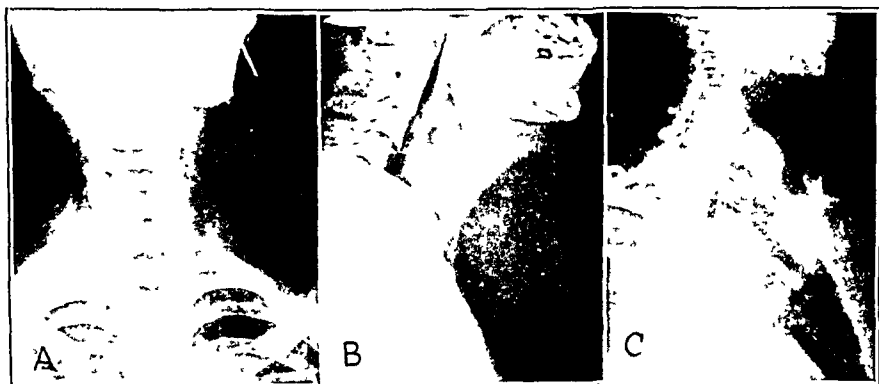


Fig. 1 (case 1).—*A* and *B*, one hour after perforation of the cervical portion of the esophagus. Note interstitial emphysema and the air-filled retrovisceral space, with anterior displacement of the esophagus. *C*, three months after perforation this esophageal diverticulum was demonstrated.

posterior wall, just above the cricopharyngeus muscle. The esophagoscope was immediately removed, and a roentgen examination revealed air in the tissues in the retropharyngeal region extending from the first cervical to the first dorsal vertebra (fig. 2).

The foot of the patient's bed was elevated, and he was given nothing by mouth. Sodium sulfathiazole (4 Gm.) was administered intravenously every eight hours, and from 2 to 3 liters of fluids were given parenterally daily.

Roentgenologic examinations on the second, fourth and sixth days following esophagoscopy showed increasing swelling in the retropharyngeal space and on the last examination a pocket of air surmounting loculated fluid.

From the time of the accident until his death, the patient complained of pain in the neck and an increasing choking sensation. He was extremely restless and apprehensive. The temperature had a daily excursion from normal to 101 F., and the respiratory rate remained essentially normal. Daily leukocyte counts ranged between 20,300 to 31,200.

The demonstration of fluid in the retrovisceral space in the roentgenograms made on the sixth day led to a decision to drain this space, but before this was

done the patient suddenly became cyanotic and died after a few minutes of asphyxia. An emergency tracheotomy was done without benefit. Permission for postmortem examination was refused.

Comment.—The infection in this case appears to have been confined to the retrovisceral space, and unquestionably death could have been averted by early drainage. Without a postmortem examination, one can only speculate regarding the cause of death. From the clinical evidence, it would appear that the abscess ruptured into the pharynx and the patient was asphyxiated from aspirating the pus.

CASE 3.—J. W., a Negro aged 39, entered the University Hospital on Dec. 4, 1945, forty-eight hours after swallowing a chicken bone. On admission his temperature was 102.6 F. and he complained of much pain in the neck and the upper portion of the chest. He stated that immediately after swallowing the bone there was pain in the right side of the neck and much distress with swallowing.

Roentgenograms of the neck revealed a fragment of bone in the esophagus at the level of the suprasternal notch, with air in the periesophageal tissues. On the day of admission an unsuccessful attempt was made to remove the foreign body by esophagoscopy. During the next twenty-four hours the temperature rose



Fig. 2 (case 2)—Roentgenograms two hours, two days and six days after perforation of the cervical portion of the esophagus. Note progressive increase in extravasated air and widening of the space between the vertebral bodies and the esophagus and the final evidence of an air and fluid-containing abscess as indicated by the appearance of a fluid level.

to a level above 104 F., where it remained until death occurred two days later. The patient was toxic, and increasing difficulty in breathing developed to the point of strangulation, which was averted by introducing a bronchoscope into the trachea while a tracheotomy was being performed. The retrovisceral space and superior mediastinum were drained at the time of the tracheotomy. There was constant moderate leukocytosis, but blood cultures were sterile.

From the beginning, fluids were withheld by mouth and an adequate intake given parenterally. Moderate doses of sodium sulfadiazine and penicillin were also administered from the time of admission.

Roentgen reexamination on the day after admission and after a swallow of barium (fig. 3) disclosed no change in the location of the foreign body. The space between the esophagus and the vertebral bodies was increased, and there was a triangular area of density of air just posterior to the foreign body as well as a bulge in the soft tissues at the base of the neck in the anterior-posterior view. A roentgenogram of the chest showed displacement of the left lung laterally by air in the mediastinum extending from the apex to the eighth rib posteriorly.

Death occurred on the fourth day in the hospital and postmortem examination revealed an esophageal diverticulum extending from the pharyngoesophageal

junction to the root of the lung and a chicken bone at the neck of the diverticulum, with perforation of the left posterior wall of the esophagus. There were also mediastinal abscesses involving both the superior and the posterior part of the mediastinum, bilateral empyema, purulent pericarditis and terminal bronchopneumonia.

Comment.—It is interesting that this patient had an esophageal diverticulum, which was probably responsible for arresting the chicken bone which perforated the esophagus. The evidence indicates that perforation had occurred prior to esophagoscopy and that there was a well established infection in the retrovisceral space and the mediastinum at the time of admission. It is doubtful, therefore, that drainage twenty-four hours earlier would have changed the outcome. The fatal delay in this case took place before hospitalization.

CASE 4.—V. L., a white boy aged $2\frac{1}{2}$ years, entered the University Hospital on April 29, 1942, dying from dehydration and bronchopneumonia. Five weeks previously he had swallowed lye and for three weeks had taken only fluids in decreasing amounts and had lost weight steadily. With hydration and oxygen

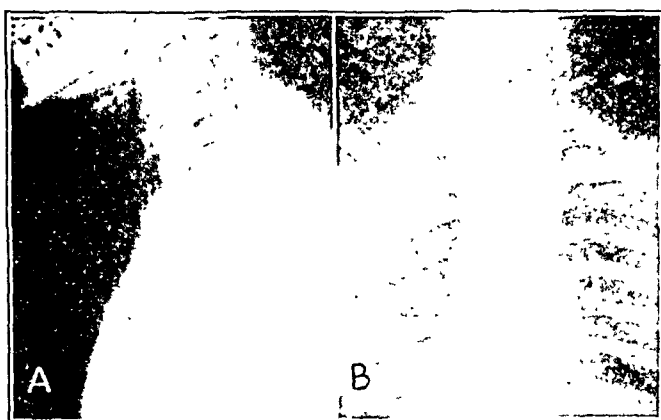


Fig. 3 (case 3).—*A*, the esophagus outlined with barium is displaced anteriorly, with a tissue density-filled retrovisceral space and a triangular area of air inferiorly surrounding the point of the chicken bone which protrudes through the posterior wall of the esophagus. *B*, in this roentgenogram note the swelling at the base of the neck on the left side and the lateral displacement of the left lung by air in the mediastinum.

there was rapid improvement, and in three days he was taking an adequate intake of liquids and soft food by mouth.

Six weeks later there was increasing evidence of esophageal obstruction, and on June 9 esophagoscopy demonstrated a stricture at the level of the thoracic inlet. On June 22 and July 27 the esophagus was dilated with bougies up to no. 20. Immediately after the second dilation there was considerable bleeding, and four hours later the patient had a temperature of 104 F. rectally, a pulse rate of 130 and rapid grunting respiration. He continued to be desperately ill, and within three days there were signs of fluid on the right side of the chest. This was confirmed by roentgenologic examination, which also revealed notable displacement of the trachea and heart to the left (fig. 4).

On Aug. 5, 1942, 400 cc. of thick foul-smelling fluid was removed from the right side of the chest. Gram-positive cocci and bacilli were demonstrated in smear and culture. Thoracenteses were repeated almost daily until closed drainage by thoracotomy was established on August 13. The pus removed from the chest contained curdled milk.

Four days after thoracotomy a Witzel gastrostomy was performed. The immediate convalescence was stormy, but after healing of the empyema and retrograde dilation of the stricture, the infant made a complete recovery.

Comment.—It is obvious that in this child the esophagus was perforated during dilation of the stricture, and it is reasonable to assume that an immediate mediastinotomy might have prevented the empyema and otherwise lessened the morbidity.



Fig. 4 (case 4).—*A*, mediastinitis and empyema on the left side following rupture of a strictured esophagus during dilation. *B*, esophagram after recovery following drainage of the empyema. Note the stricture in the proximal thoracic portion of the esophagus.



Fig. 5 (case 5).—*A*, this roentgenogram, made a few hours after a self-inflicted perforation of the thoracic portion of the esophagus, shows interstitial emphysema of the neck and evidence of bilateral basal atelectasis with small quantities of fluid in both costophrenic sinuses. *B*, in this esophagram after recovery from the mediastinitis resulting from perforation there appears not only the stricture at the junction of the upper and middle thirds but also barium outside of the esophagus, presumably in a sinus tract in the mediastinum and a residue of the perforation.

CASE 5.—S. C., a white woman aged 59, was admitted to the University Hospital on Jan. 31, 1946. At the age of 4 she had swallowed lye, and on many occasions since then food had impacted at the area of stricture. She stated that when this occurred she was usually able to force the food down by swallowing

a soft rubber catheter. Three months previously a plum seed which could not be dislodged was removed by esophagoscopy. A few hours prior to her admission to the hospital a piece of meat failed to pass the stricture, and while attempting to force it down with a catheter stretched over a wire stilet she experienced a sudden sharp pain in the precordium and right flank and much dyspnea.

Roentgen studies (fig. 5) revealed air in the soft tissues of the neck and consolidation or atelectasis in the bases of both lungs. Conservative treatment with parenterally administered fluids and large doses of penicillin was carried out, with complete recovery after twenty-nine days in the hospital. The patient was extremely ill for ten days, with temperatures to 104 F. and much respiratory distress. There were no significant laboratory findings except a leukocyte count of 17,400 on admission.

Serial roentgenograms revealed regression of air in the soft tissues and clearing of the consolidation of the lungs. An esophagram on the twenty-seventh day in the hospital demonstrated a constriction of the esophagus at the level of the bifurcation of the trachea, with a fistulous tract or a diverticulum extending inferiorly from its anterior portion. At the time of discharge from the hospital she was able to swallow soft foods without difficulty.

Comment.—This patient is of interest in respect to both the mechanism of perforation and the recovery without surgical intervention. Also of interest is the presence of barium in a sinus tract or diverticulum leading inferiorly from the lumen of the esophagus at the site of stricture in the follow-up esophagram.

DISCUSSION

DR. C. J. HUNT, Kansas City, Mo.: I should like to report a case of rupture of the esophagus not due to intraesophageal trauma but due to external trauma from an automobile accident.

One can see how an automobile accident can produce serious trauma to mediastinal structures, namely, vessels and so on, but it is difficult to see how external trauma can rupture an esophagus.

A middle-aged man was in an automobile accident. After the accident he did not seem to be severely injured. There were no external evidences of trauma. He returned to his place of business, a night club. He did have some pain at the time of the accident, located in the upper part of the abdomen or just below the lower part of the sternum. This passed off, but it returned after he reached his place of business. He thought he would relieve himself by drinking several bottles of beer, which he did. That did not give him satisfactory relief, so he took a couple of highballs. That did not give him relief either.

A physician was called, and he gave the man two injections of morphine, each about $\frac{1}{4}$ grain (0.02 Gm.). Later he was brought to the hospital. At that time he was comfortable and did not seem to be in distress. No evidence of external trauma could be found, and on examination there was no evidence of any serious internal injury.

Subsequently, roentgenologic examination was carried out. Air was found to be distributed in the mediastinum, and a barium picture was made. Some barium was swallowed. (Slide) Here the esophagus is visualized. You see the esophagus compressed to one side at this point and free air outside of the esophageal tract. This region was explored. A longitudinal rent was found in the lower portion of the esophagus, which I understand is the type of rent that occurs from external violence or from an injury to the esophagus not occurring from intraesophageal manipulation. This was sutured.

There was evidence of an extreme amount of extravasation, beer and whisky, an extreme amount of edema, waterlogging of the tissues and mediastinitis. The wound was closed with a mattress suture of silk. The site was drained. The patient died in four days. Autopsy showed a spreading type of mediastinitis and infection of the pleural cavity. The sutures were still intact. The suction tube had not eroded the suture line.

The patient died from sepsis. This case illustrates the importance of always keeping in mind the possibility of severe internal injury even though the initial symptoms do not indicate it. The manifestation may be slow in developing. An injury of this nature could only occur from a sudden tension and change of mediastinal and intraluminal pressure. The injuries occurring from intra-esophageal instrumentation are, no doubt, more common than would appear from the report. The presentation by Dr. Bisgard has been most instructive and interesting.

DR. KELLOGG SPEED, Chicago: I should like to report a case of a little different type of pathologic process resulting from this injury. It was a case of a man with a carcinoma near the lower end of the esophagus. The internist was treating him by dilation and, without his knowledge, perforated the esophagus. The point of the bougie went on down and perforated the cardiac end of the stomach and landed in the spleen.

The patient lived about four weeks without any great distress and finally died. At autopsy the tract that I have just described was perfectly evident. One could see where the bougie had gone down, and in the spleen was one large area of solitary metastasis, evidently implanted by the point of the bougie, growing rapidly. There was some local peritonitis, but the exact cause of death was not really ascertained.

The bougie or the dilation, in the case of carcinomatous constriction, may inseminate additional metastasis.

DR. THOMAS J. KINSELLA, Minneapolis: Dr. Bisgard has called to our attention an important surgical problem which frequently is overlooked. Our medical colleagues are inclined to delay calling these accidents to our attention; Consequently, we see the patients hours afterward. They should be examined promptly, within the hour if possible, certainly as promptly as a patient with a perforated peptic ulcer.

I am in complete accord with what Dr. Bisgard has said. I believe in immediate operation for cervical perforations, with bilateral drainage of the retrovisceral space and the mediastinum. Chemotherapy alone will not take care of the larger perforations.

Another type of emergency which we should also recognize is the perforation in the lower part of the esophagus of more or less spontaneous type. It may follow insignificant trauma, such as from the passage of a stomach tube of soft type, but may occur as a completely spontaneous accident. It is prone to occur in postoperative vomiting and in pregnancy but more commonly in the patient who likes to overeat and overdrink, as an apparently spontaneous perforation.

It is an extremely serious condition. There is rapid development of shock; mediastinal emphysema occurs which, if it works upward, may be present in the supersternal notch. The condition must be recognized promptly. At least half of the patients reported on have been subjected to an exploratory laparotomy, without any result. The perforation is into the mediastinum and then into the pleural cavity, usually on the left. If roentgenograms are taken in the erect position a fluid level and a tension pneumothorax will be found. If you give

the patient a little grape juice to drink it will appear in the pleural fluid and can be recognized, confirming the perforation, as will the finding of gastric acids in the fluid.

You may treat the patients for shock for hours or days, but they will not come out of it. The tension pneumothorax must be relieved first, after which the patient must be operated on promptly in spite of the shock. He will come out of shock when the chest is explored, when the mediastinum is decompressed, the perforation of the esophagus closed and continuous drainage of the pleural cavity established.

It is a serious situation. We should think of it particularly when we have a case of suspected perforation of ulcer at hand, because the condition resembles perforation of a peptic ulcer and has been mistaken for it in the majority of instances.

DR. ROGER VAUGHAN, Chicago: I should like to add a word to this discussion of spontaneous perforations. I have seen 5 or 6 cases, and all the patients have died. Two of our staff members in the Cook County Hospital observed their first cases in private practice and did not recognize the symptoms because they did not know of the condition. The condition was diagnosed as perforated peptic ulcer, and of course a laparotomy was without value.

I do not consider these lesions at all difficult to diagnose. All those I have seen were in patients with chronic alcoholism. These patients have esophagomalacia in the lower end which is easily demonstrated at autopsy.

The outstanding feature which should help one to make the diagnosis, once one is aware that there is such a condition, is that in cases of perforated peptic ulcer the vomiting follows the perforation. The pain comes first and then the vomiting. With esophagomalacia, the perforation is caused by the violent vomiting, and then a sudden severe pain in the epigastrium follows.

Furthermore, in the cases of esophageal perforations there is not either the intense rigidity of a perforated peptic ulcer or the completely silent abdomen, and if you look carefully for a pneumoperitoneum in these cases, you will see that instead of it there is fluid in the left pleura or in both pleurae, and if you turn the patients laterally you will see the air in the mediastinum and sometimes a fluid level too.

The main thing to keep in mind is that when you suspect perforated peptic ulcer and the patient vomits violently, the clue to diagnosis is: Did the vomiting come first or did the pain come first?

DR. J. DEWEY BISGARD, Omaha: I want to thank Dr. Hunt, Dr. Kinsella, Dr. Speed and Dr. Vaughan for their splendid additions to this discussion and refer any one interested to the article by Dr. Kinsella in the current issue of the *Journal of Thoracic Surgery* for a complete discussion of spontaneous perforations.

There is a certain advantage in instrumental perforations in that there is usually knowledge that a perforation is present. The endoscopist sees the perforation develop, and in other instrumental perforations there is usually evidence within a few hours, in the form of fever and pain, that the perforation has occurred. With this advantage there is no excuse for not establishing drainage early, except for the delay in receiving surgical consultation. Too often we see the patients late, and the mortality is more or less inversely proportionate to the time that elapses before drainage is established.

The main purpose of my paper is to emphasize the need of early diagnosis and the establishment of drainage immediately or within a few hours after perforation occurs.

HEMIHEPATECTOMY WITH HEPATICOJEJUNOSTOMY FOR IRREPARABLE DEFECTS OF THE BILE DUCTS

R. L. SANDERS, M.D.

MEMPHIS, TENN.

OF THE numerous methods of repair of defects of the bile ducts, the two which are generally considered most dependable are direct end to end anastomosis of the distal and proximal segments of the duct and anastomosis of the proximal portion to the duodenum or jejunum. The first of these procedures is obviously the method of choice and, when the defect is short, is usually applicable. For strictures limited to the ampullary region with dilatation of the duct above, a choledochoduodenostomy or choledochojejunostomy affords an effective and physiologic means of overcoming the obstruction.

In the presence of extensive destruction of the ducts, the problem is far more serious. Within recent years, hepaticojejunostomy with a supplementary enteroenterostomy, as suggested by Allen¹ and by Warren Cole,² has gained wide acceptance as a logical solution. After these procedures, however, one is confronted with the possibility of stricture at the site of the hepaticojejunostomy, with consequent obstruction of the flow of bile and progressive hepatic damage.

Longmire³ has recently described an operation which he has employed with success in a case of extensive acquired stricture of the extrahepatic ducts after two attempts by other means had failed. His operation consisted of upward dissection of the left lobe of the liver until a suitable duct for anastomosis to the jejunum was found, resection of a wedge-shaped segment of the left lobe in this area, coring out of the liver about the duct to provide a sufficient length for reconstruction and anastomosis of the end of the duct to a small opening into the side of the jejunum over a short rubber tube. The anastomosis was reenforced by suture of the antemesenteric border of the jejunum to the superior surface of the liver capsule along the cut edge. A sup-

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 3, 1948.

1. Allen, A. W.: A Method of Reestablishing Continuity Between the Bile Ducts and Gastrointestinal Tract, *Tr. South. S. A.* **61**:28, 1944.

2. Cole, W. H.; Irencus, C., Jr., and Reynolds, J. T.: Use of Vitallium Tubes in Strictures and Absence of the Common Bile Duct, *Ann. Surg.* **122**:490, 1945.

3. Longmire, W. P., Jr., and Sanford, M. C.: Intrahepatic Cholangiojejunostomy with Partial Hepatectomy for Biliary Obstruction, *Surgery* **24**:264, 1948.

plementary enteroenterostomy was then made. Fortunately, as he pointed out, the periductal fibrosis thickens the duct wall so that it is well adapted to suture and the back pressure incident to obstruction dilates the duct to a size adequate for anastomosis. In this operation, Longmire clearly demonstrated a ductal communication from the right to the left lobe sufficient to provide ample bile drainage, thus substantiating previous experimental evidence of an interlobal connection of the ducts.

I am reporting herein the case of a patient with irreparable destruction of the bile ducts who was treated by hemihepatectomy and hepaticojejunostomy in a manner similar to that suggested by Longmire.

The patient, a woman aged 23, had been subjected to cholecystectomy elsewhere eight months previously. She had become jaundiced soon after the operation, and one month later the surgeon had inserted a tube for drainage. At the time of her first visit the tube was still in situ and was draining bile-stained fluid almost continuously. She was having episodes of chills and fever at frequent intervals, had lost 20 pounds (9.1 Kg.) in weight and had been in bed most of the time since the operation.

On examination the patient was rather severely jaundiced and showed evidence of loss of weight. The liver was enlarged, and tenderness was elicited in this region. The icterus index was 45, the prothrombin time was 37 seconds and the direct vanden Bergh reaction was positive. It was apparent from the history and these findings that the common duct had been damaged surgically and that operative repair would be necessary. After preparation with several blood transfusions, the administration of vitamin K and other measures, the operation was undertaken under spinal anesthesia.

When the abdomen was opened, the common duct was identified with difficulty because of extensive adhesions secondary to the former operation. A segment $1\frac{1}{2}$ to 2 inches (3.8 to 5 cm.) in length had previously been removed from the duct. The distal portion was so short that an end to end anastomosis with the proximal portion was impossible, and it was left undisturbed. The proximal portion had sloughed away up into the hilus of the liver, and a complete stricture in this area had produced a large bile cyst. After removal of the contents of the cyst, the segment was united to the jejunum by the Allen technic, i. e., the jejunum was divided about 12 inches (30.5 cm.) below the ligament of Treitz, the distal end drawn over the transverse colon, the mucosa invaginated and the serosa sutured to the hilus of the liver around a tube inserted into the stump of the duct. The tube, which was bell shaped at the upper end and contained an opening within the lumen of the jejunum for passage of the bile, was brought out through the side of the jejunum and through the abdominal wall. The proximal portion of the jejunum was anastomosed to the distal segment as a Roux Y procedure, thus reestablishing the continuity of the intestinal tract.

The patient's progress was satisfactory after this procedure; the jaundice cleared, and the wound healed. Two weeks after her discharge from the hospital, however, a digestive disturbance developed and she again became jaundiced. She was given medical treatment but continued to have difficulty; the chills and fever recurred, the icterus index rose steadily and the liver increased in size. Eighteen months postoperatively she began passing blood through the intestinal tract, presumably incident to obstruction of the duct at the site of anastomosis, though some bile was still present in the stools. She was given blood transfusions

and again treated medically, with temporary benefit. The chills, fever and jaundice then increased, the icterus index reached 100, the stools became colorless and the enlargement of the liver grew pronounced. Since the obstruction was now apparently complete, surgical treatment was again recommended. Two years had elapsed since the first reconstructive procedure.

After thorough preparation of the patient, the upper part of the abdomen was opened and, as on the previous occasion, was found filled with adhesions. Both lobes of the liver were enormously enlarged and firm. The jejunal loop which had been utilized as a substitute for the common duct had contracted at the

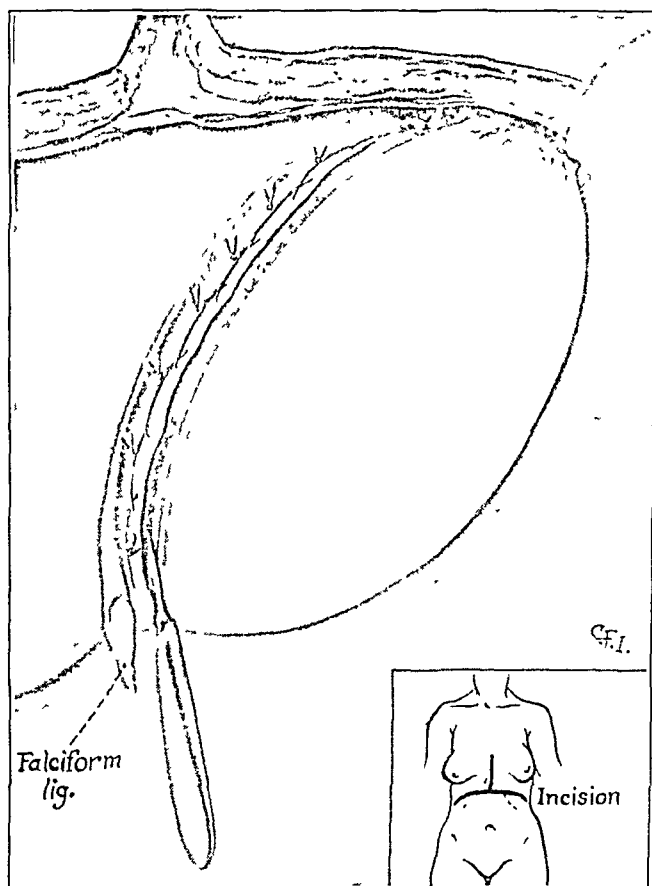


Fig. 1.—Inverted T type of incision (insert). Through this incision the triangular ligament was severed and the liver easily brought into the wound. Hemostatic mattress sutures of heavy surgical gut have been placed along the falciform and round ligaments. Resection is begun at the posterior surface and brought toward the anterior surface of the liver.

site of anastomosis in the hilus of the liver and produced complete obstruction. It was severed at this point and resected for a distance of 2 inches (5 cm.). The hilus was then spread with forceps, which opened a large cavity filled with bile and containing several small stones. The cavity having been evacuated, a search for the ends of the ducts was made with a probe, but none could be found in either the right or the left lobe. There was simply a large opening in the hilus of the liver. The bell end of a no. 14 catheter was therefore sutured in

the hilus, and the tip was brought out through the jejunum 10 inches (25 cm.) below and thence through the abdominal wall. The jejunum was then sutured to the edge of the liver all around the tube, without inversion of the mucosa. Other drains were inserted to the hilar region and brought out through a stab wound.

The bile drained well, and the patient made excellent progress for about six weeks. At that time, cramping pain in the abdomen developed, and she had a mild chill with fever. A few days later she began vomiting blood and passing blood through the bowel, and she again became jaundiced. Examination

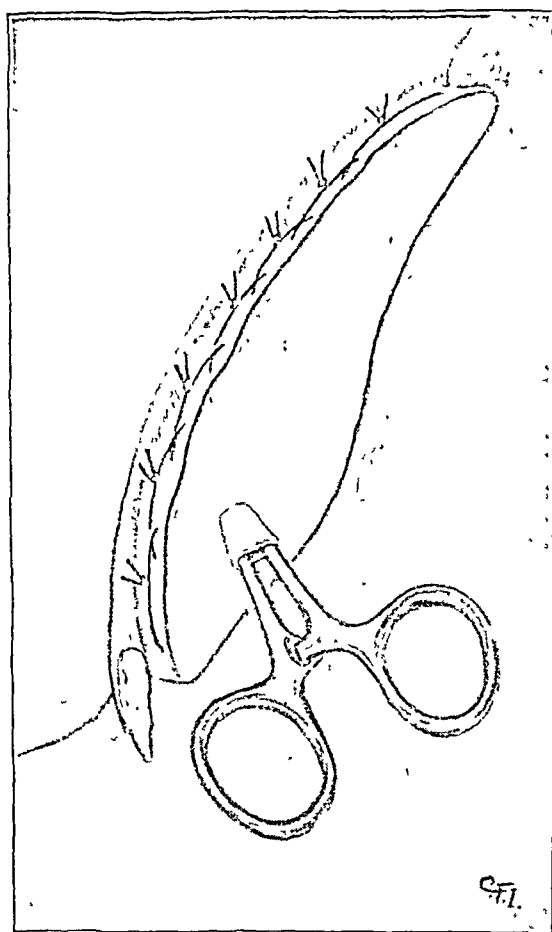


Fig. 2.—The entire left lobe of the liver has been removed and hemorrhage controlled by mattress sutures. The large left hepatic duct has been freed for nearly 2 inches (5 cm.) and a $7\frac{1}{2}$ inch (19 cm.) forceps inserted into the duct, which demonstrates its depth and probable connection with the right side.

showed the liver still enlarged, the left lobe more so than the right. The icterus index was 23. She was given transfusions and given medical treatment, but she returned five weeks later with abdominal distention, further enlargement of the liver and an icterus index of 55. The stools, however, were still slightly colored. It was evident that more drastic measures would be necessary in order to provide a better outlet for the flow of bile, which had been obstructed for so long by recurrent strictures at the hilus of the liver. With the experimental and surgical evidence of an interlobal communication of the ducts reported by

Longmire as a background, it was decided to remove the entire left lobe of the liver, isolate the left hepatic duct, determine its communication with the right lobe and anastomose the end of the left duct to the side of the jejunum.

Five and one-half months after the preceding operation, the abdomen was reopened transversely at the costal margin, with division of the rectus muscles and a supplementary midline incision, which formed a T-shaped approach. Both lobes of the liver were tremendously enlarged, the left slightly more than

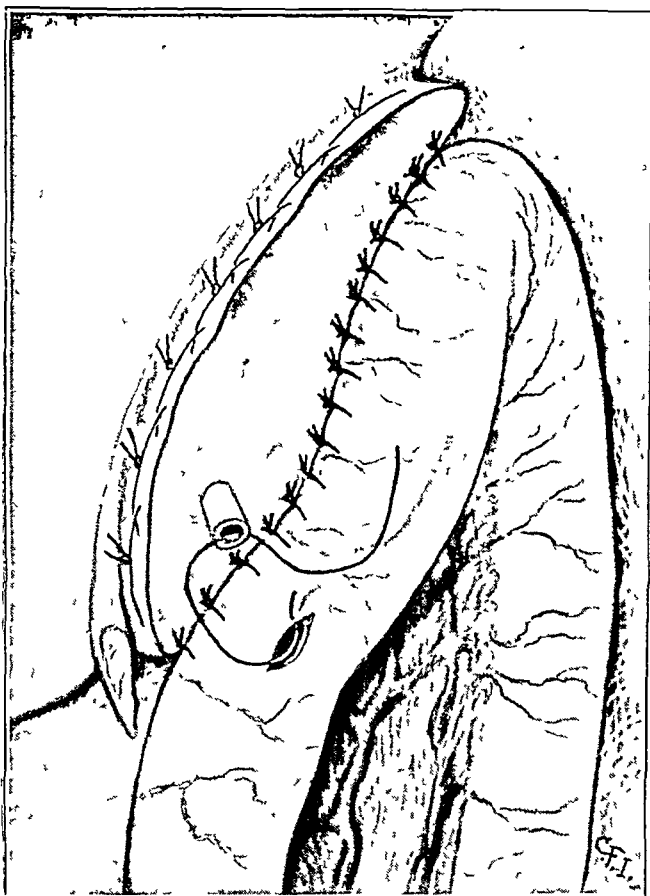


Fig. 3—The first step of the anastomosis of the open end of the left hepatic duct to the antemesenteric surface of the jejunum. Mucosa to mucosa anastomosis is done with interrupted sutures of fine surgical gut. The jejunal loop is attached to the under surface of the liver by interrupted sutures of fine silk preparatory to being folded over as the final step of the operation, shown in figure 4.

the right. The spleen was $2\frac{1}{2}$ times normal size. The triangular ligament of the left lobe was severed and the lobe elevated. The dividing line between the right and left lobes was found, and mattress sutures were inserted with long straight needles through and through the liver to control the hemorrhage. The left lobe was then removed. The loss of blood was considerable, but it was satisfactorily controlled by continuous suture of the borders of the liver with surgical gut in addition to the mattress sutures previously applied. The left hepatic duct was isolated as the lobe was being removed, and a segment about

2 inches (5 cm.) long was freed to be used for the anastomosis. A large artery along the under surface of the hepatic duct was ligated by suture around the artery at the border of the duct. After this procedure, an artery forceps was inserted 4 or 5 inches (10 to 12 cm.) into the open end of the left duct, which demonstrated a definite communication between the right and left lobes. At this point, bile escaped freely from the open duct; since the left lobe

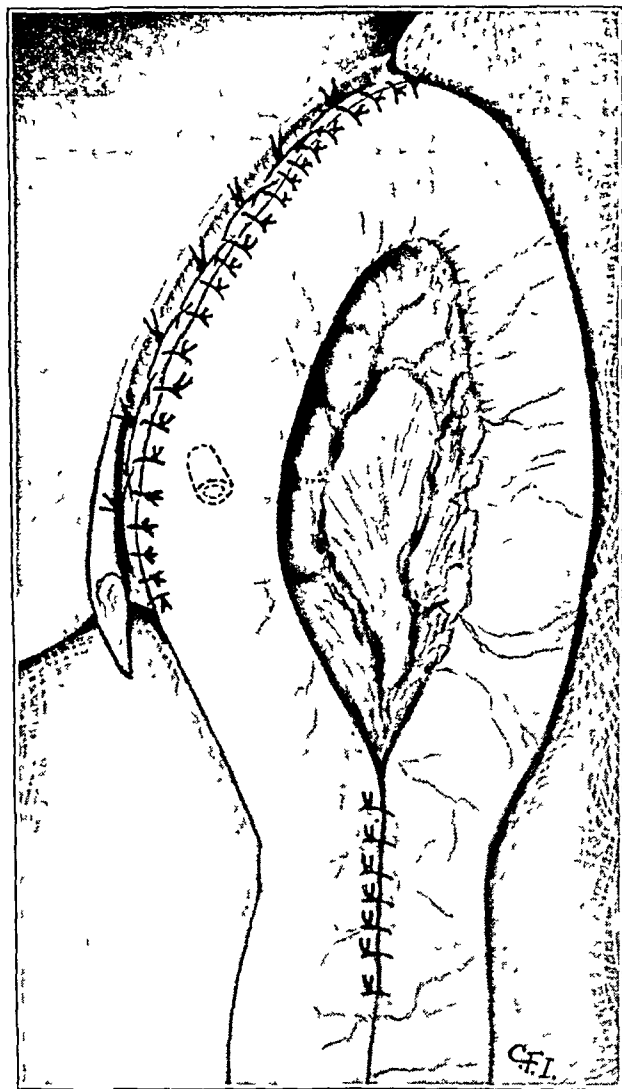


Fig. 4—Anastomosis of the open end of the left hepatic duct to the jejunum as an end to side anastomosis. The operation is completed by suture of the jejunum to the anterior surface of the liver with interrupted sutures of fine surgical gut. Enteroenterostomy is performed about 6 inches (15 cm.) below, as a precaution against regurgitation of the intestinal contents into the left hepatic duct.

had been removed, it was evident that the bile came from the right side. The duct was surprisingly large, being almost the size of the average fountain pen, and its walls were thick and fibrous, thus lending themselves well to suture.

The loop of the small intestine just proximal to the former Roux Y anastomosis was next brought through the transverse mesocolon at the hepatic flexure and sutured to the end of the hepatic duct as an end to side anastomosis. Since the duct was sufficiently large to permit suture of mucosa to mucosa, an indwelling tube was unnecessary. To prevent traction on the anastomosis, the jejunum was sutured to the cut surface of the liver for a considerable distance on both sides of the anastomosis. A lateral enteroenterostomy was then performed just below this point. Finally, as a further precaution against slipping, the transverse mesocolon was sutured to the limb of the bowel at its emergence

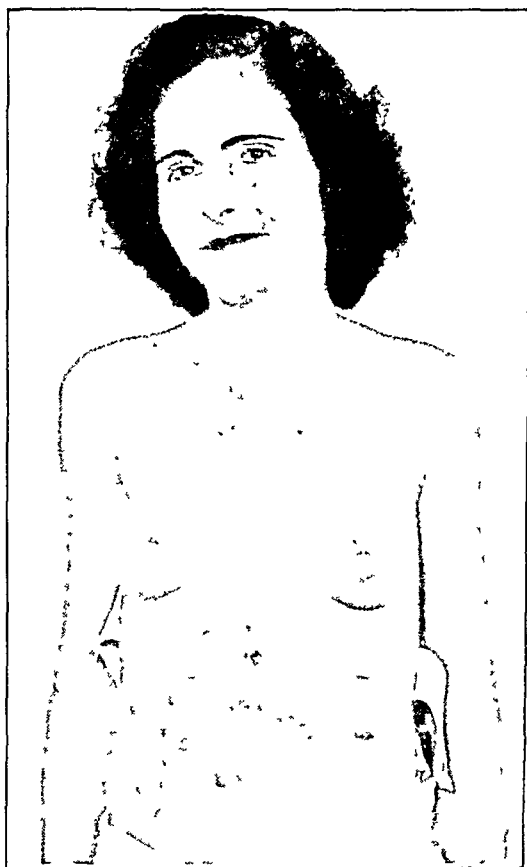


Fig 5.—Photograph of patient four months postoperatively, showing evidence of gain in weight and complete healing of the wound. The previously enlarged liver has almost returned to normal size.

from the mesocolon. It was believed that the bile would now pass freely through the new anastomosis. The previously made hepaticojejunostomy opening (Allen operation) to the right lobe was not disturbed. Since a small amount of drainage from this lobe had persisted, the hepatic damage was not considered too severe to prevent recovery. The abdomen was thoroughly cleansed, and, in order to hasten convalescence, closure was completed without drainage. Since the hepatic wound seemed dry, the omission of drains appeared to be perfectly safe. Transfusions consisting of a total of 2,000 cc. of whole blood were given throughout the operation.

The patient's convalescence was complicated by the development of bile peritonitis. Closure without drainage had been an error. After the institution of drainage, however, the peritonitis promptly cleared and she had no further difficulty. At the time of her discharge from the hospital, the jaundice was much less noticeable, the icterus index was lower, the right lobe of the liver had diminished in size and her general condition had improved.

Since leaving the hospital, she has been seen every few weeks. The chills and fever have not recurred, which indicates that she has been free from ascending infection, and the hepatitis has continued to subside. The duct and the anastomosis have remained patent, as shown by the fact that she has passed the usual amount of bile through the intestinal tract.

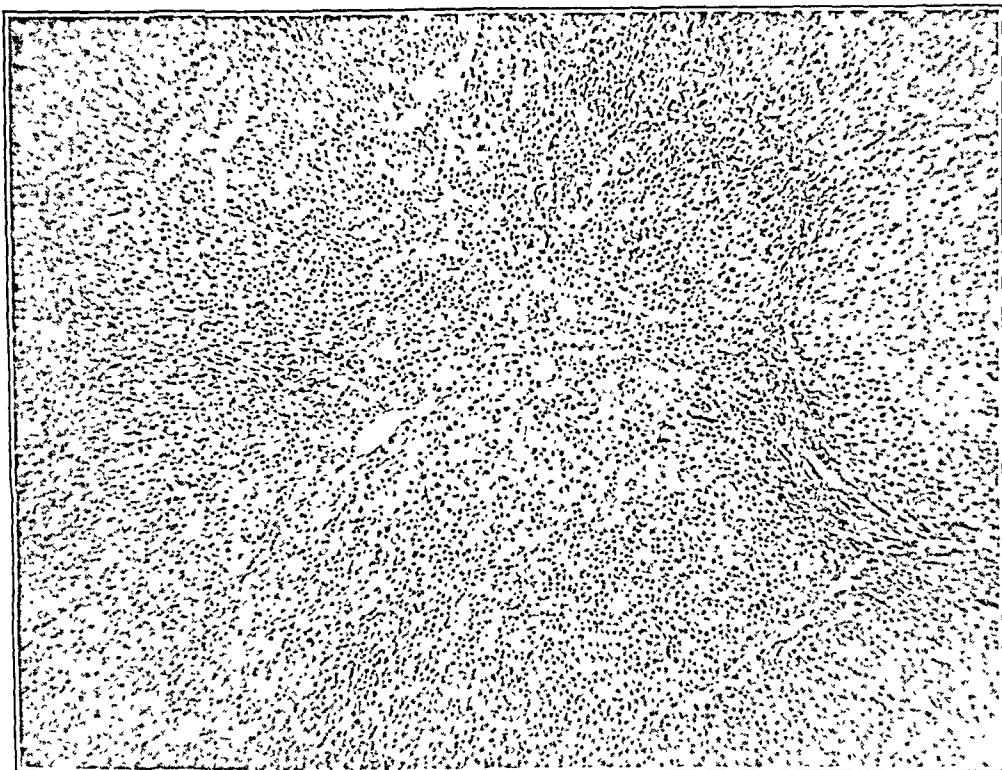


Fig. 6.—Photomicrograph of pathologic section showing distortion of liver lobules by increased connective tissue. The connective tissue is moderately infiltrated by lymphocytes. The diagnosis is early biliary cirrhosis.

At the last observation, Nov. 23, 1948, she reported that she was feeling much improved, was taking a well balanced diet, had gained strength and was doing her housework. Her skin was still a little icteric, though the bowel function was regular and the stools a normal brown color. She weighed 120 pounds (54 Kg.), which represented a gain of 20 pounds (9 Kg.) since the operation.

Physical examination showed that the wounds had healed without the occurrence of hernias. No mass was palpated in the region formerly occupied by the left lobe of the liver. The right lobe had receded and was practically normal in size; it could be palpated at the rib margin just beneath the right angle of the scar but was not tender. There was a slight fullness in the upper abdominal area, probably incident to the crowded tissues in the region of the last anastomosis. The continued slight jaundice was believed to be secondary to the poorly drained portion

of the right lobe through its normal hilus where the Roux arm (Allen operation) was last attached.

The patient stated that she was well pleased with the result as compared to her former condition. It had been approximately three years since the first operation (Dec. 12, 1945), and her condition was better than it had been at any time since the cholecystectomy was performed elsewhere several months earlier.

The report on the pathologic study of the specimen of liver was as follows:

Gross Appearance.—The specimen consists of approximately the left lobe of the liver, measuring 20 by 12 by 6 cm. Its external surface has a mottled brownish and purple color. Serial sections reveal a yellowish green color, which is uniform and diffuse throughout. There is no coarse nodularity on either its external or cut surfaces, though the consistency is relatively firm throughout.

Microscopic Appearance.—Several sections present essentially the same appearance. The liver nodules are moderately distorted, incident to increased fibrous connective tissue, chiefly between and in the portal triads. Within this collagenous tissue there is a moderate but diffuse infiltration of lymphocytes and occasional macrophages. Within the liver lobules are scattered foci showing many canaliculi distended with a brown pigmented material; otherwise, the parenchyma is not remarkable. There is some proliferation of the small bile ducts in the fibrous stroma.

Diagnosis.—The diagnosis is early biliary cirrhosis.

COMMENT

This case is reported because of the unusual features and because the demonstration of an interlobal communication of the ducts seems to substantiate the views expressed by Longmire. Technically, the operation described is most difficult and the risk is great. The most serious problem is the danger of hemorrhage, though this can be overcome by the use of continuous transfusion. Fortunately, the indications for surgical measures of such magnitude are rare. Desperate conditions, however, require desperate means, and when one has no other recourse, as in this case, the procedure is justified.

DISCUSSION

DR. WARREN H. COLE, Chicago: First, I wish to state that I consider this operation to be useful in certain cases, particularly those in which one is unable to find the stump of duct at the hilus. I intend to utilize it but as yet have had no occasion to do so.

I also want to make my position clear about the use of tubes of various types. I believe that tubes should not be put in the common duct to remain permanently. I am convinced of that. I think probably Dr. Sanders feels he would not use them at all, but I do think that some sort of support is indicated in most of the anastomoses which one makes between a bile duct and some other structure such as a loop of jejunum. I feel that if this tube is left in place for eight to twelve weeks the stenosis associated with cicatrization will be minimized much more than if no tube is used. True enough, we do not have good experimental data to back up that statement. I may not be correct in it, although I do believe that most surgeons working in this field feel that some sort of support is desirable.

Dr. Sanders has kindly referred to an operation which my associates and I reported recently. This operation was designed for patients in whom stricture had formed at the hilus of the liver. I am sure those of you who are doing these

operations agree with me in identifying the hilus as the site where most of the strictures occur, particularly if one or two attempts have already been made at repair. We have long since discovered that at numerous areas throughout the body we counteract the stenosing effects of cicatrization by grafts. For this reason we devised a method in which we utilize a cuff of mucosa and submucosa on the end of an arm of jejunum as a graft to insert into the scarred area at the exit of the bile duct in the hilus of the liver. We have performed this operation on only 4 patients but have been very pleased with its results up to date.

As I intimated previously, I had 2 patients on whom I thought I would do the Longmire procedure which Dr. Sanders is reporting. In spite of the fact that we made free use of a syringe and needle, which usually is successful in finding the duct, we were unable to locate it in these 2 patients. We had already utilized so much operating time that we did not believe adoption of another procedure would be justifiable. We closed the abdomen (with a Penrose drain at one end), expecting later to reoperate on them and utilize the Longmire technic. However, we were somewhat surprised that a free flow of bile was established in forty-eight to seventy-two hours in both of the cases. Apparently bile precipitate had plugged our needle, thus preventing aspiration of bile, but we had made so many perforations in the duct that drainage of bile took place spontaneously. Accordingly, we reoperated on the patients, utilizing our mucosal graft technic previously referred to.

I wish to reiterate that this procedure on which Dr. Sanders has reported is a definite contribution, particularly when one is unable to find the duct. On such occasions it may be very useful.

DR. THOMAS G. ORR, Kansas City, Kan.: I do not want you fellows from the north to think that I am going to criticize the way this subject was presented or what was presented. It was a magnificent case report by this gentleman with "egg on his vest." If I have a case like this I am going to operate exactly as he did, with one exception. I am not going to use a loop of jejunum, but I am going to cut it in two and use the Roux Y method instead of the loop of jejunum.

I have little confidence in the so-called Braun anastomosis from one loop of the jejunum to another. I do have much confidence in peristalsis, and I think that it is a deceptive measure to use an enteroanastomosis when you are draining something and do not want the intestinal content to go past that point of drainage.

DR. R. L. SANDERS, Memphis, Tenn.: In answer to Dr. Jackson's question, we have had no occasion to try this procedure for congenital atresia of the bile ducts, though it has been our experience that the atresia extends so deeply into the liver substance that the operation would not be applicable. A few weeks ago I wrote to Dr. Robert Gross, of Boston, for his opinion, and he replied that he had tried the operation on infants but was never able to find a duct sufficiently large for anastomosis to the intestinal tract. He tried removal of a portion of the liver and suture of its raw surface to the open intestine, but this also failed.

Dr. Orr states that he would prefer using the end rather than the side of the jejunum for anastomosis to the hepatic duct. He has in mind the diversion of food from the hepatic duct to avoid ascending infection. Since I had already used the Roux operation in this case, I decided to make a lateral anastomosis, with an enteroenterostomy below. It is my impression that this will serve the purpose as well. For many years we have used a lateral anastomosis in uniting the gall-bladder or common duct to the intestinal tract. I have recently looked up 45 of these cases, and they have been successful; none of the patients has had evidence of ascending infection. Possibly the answer is a wide anastomosis which will not stricture.

GASTROJEJUNOCOLIC FISTULA

STANLEY E. LAWTON, M.D.

AND

ARTHUR R. MARKS, M.D.

CHICAGO

GASTROJEJUNOCOLIC fistula following gastroenterostomy for gastric or duodenal ulcer is seldom observed by the individual surgeon and appears relatively infrequently in the large clinics. To date slightly over 300 cases have been reported. The complication of a fistulous tract between stomach, jejunum and colon resulting from operation for peptic ulcer is a serious one. It exerts a marked effect on the nutritional state of the patient, its treatment requires major surgical procedures and the mortality incident to its occurrence is high. During the past twenty years, 22 patients with gastrojejunal fistula were admitted to the Veterans Administration Hospital, Hines, Ill. The purpose of this paper is to report a study of their cases, to add to the literature 2 cases with complications not known to have been previously described and to present 2 cases in which a new surgical procedure has been successfully employed.

The average age of our patients was 45 years. The youngest patient was 32 and the oldest 54 (table 1). The average age at the time of the original operation for ulcer was 34. The youngest was 24 and the oldest 52 (table 2). A history of ulcer for periods of from eighteen months to thirty-one years antedated these operations. Although duodenal exclusion procedures of Finsterer and Devine are considered conducive to formation of marginal ulcers, none of the patients in our series had been subjected to these operations. Twenty-one of the 22 had undergone posterior gastroenterostomies, and in 1 patient an anterior anastomosis had been performed. Considerable difference was found in the time interval between the original anastomosis and the onset of symptoms attributable to presence of a fistula. This varied from eight months to twenty-two years, with an average lapse of time of six years and two months (table 3). Similar variations have been previously noted.

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From the Department of Surgery, University of Illinois College of Medicine and Veterans Administration Hospital, Hines, Ill.

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Ransom¹ reported a variation of from one to twenty-six years, with an average of nine years and six months, and Langemeyer² recorded 1 case in which a fistula developed forty years after gastroenterostomy.

Diagnosis was made in the majority of our cases from the history and confirmed by the other findings. All 22 patients gave histories of

TABLE 1.—*Age Incidence*

Age, Years	No. of Cases
20 to 29.....	0
30 to 39.....	4
40 to 49.....	13
50 to 59.....	5
Youngest patient.....	32
Oldest patient.....	54
Average age.....	45

TABLE 2.—*Age at Time of Original Operation for Ulcer*

Age, Years	No. of Cases
20 to 29.....	8
30 to 39.....	8
40 to 49.....	4
50 to 59.....	2
Youngest patient.....	24
Oldest patient.....	52
Average age.....	34

TABLE 3.—*Time Between Original Operation and Onset of Symptoms of Fistula*

Time, Years	No. of Cases
Less than 2	5
2 to 4.....	7
5 to 9.....	4
10 to 15.....	5
Over 15.....	1
Longest interval.....	22 yr.
Shortest interval.....	8 mo.
Average interval.....	6 yr. to 2 mo.

typical ulcer symptoms, failure of medical management and subsequent gastroenterostomy. After operation they had experienced a period of relief, after which abdominal pain, diarrhea, loss of weight and weakness appeared (table 4). The pain was of two types. Four of the patients complained of an initial periumbilical distress, more pronounced

1. Ransom, H. K.: Gastrojejunal Colic Fistula, *Surgery* **18**:177-190, 1945.

2. Langemeyer, cited by Thomas, J. R.: Gastrojejunal Colic Fistula with Report of Five Cases, *Mil. Surgeon* **87**:232-238, 1940.

in intensity than that caused by their original ulcer. All patients complained of a less characteristic pain in the lower abdominal area of a type usually associated with obstruction of the small or large bowel. Presumably the pain in the first instance was due to presence of marginal ulcers, whereas the latter type of pain was of mechanical or inflammatory origin resulting from the presence of fistulous tracts. In view of the fact that marginal ulcer is a prerequisite to the development of gastrojejunocolic fistula, it seemed that the number having the type of distress characteristic of marginal ulcer was exceedingly low.

Loss of weight, weakness and malnutrition were present in all patients. The average loss of weight was 30.9 pounds (14 Kg.) and the maximum 54 pounds (24.5 Kg.). Malnutrition was extreme in 3 patients, considerable in 5 and moderate in 11.

TABLE 4.—*Symptoms*

	No. of Cases
Pain—stomal ulcer type.....	22
Loss of weight.....	22
Weakness (malnutrition).....	22
(a) extreme.....	3
(b) considerable.....	8
(c) moderate.....	11
Diarrhea	22
(a) severe.....	17
(b) moderate.....	5
Fecal eructations.....	10
Vomiting	9
Hematemesis	1

Diarrhea was a constant finding and the most aggravating of all symptoms. Every one of the 22 patients complained of loose stools. These began as recurrent short attacks and increased in frequency until in several instances they occurred fifteen to twenty times daily. Eight patients complained of tarry or dark red stools early in the course of their illness, and 1 patient vomited bright red blood. Opinions regarding the cause of the constant finding of diarrhea have changed somewhat in recent years. At one time it was thought that rapid emptying of gastric contents into the colon was the causative factor. Pfeiffer,³ however, observed fluoroscopically that barium passes extremely slowly from the stomach into the bowel, whereas passage in the reverse direction from colon to stomach takes place much more rapidly. He expressed the belief, therefore, that the diarrhea is initiated by regurgitation of the contents of the colon into the stomach and jejunum, which

3. Pfeiffer, D. B.: Surgical Treatment of Gastrojejunocolic Fistula, Surg., Gynec. & Obst. 72:282-289, 1941.

in turn induces a hyperperistalsis in the jejunum, with speedy emptying of the small bowel into the colon. Further support has been given to this opinion by Barber and Madden⁴ and by Renshaw, Templeton and Kiskadden,⁵ who recently demonstrated, in dogs and in patients, that ordinarily sufficient gastric content does not pass directly into the colon to bring about diarrhea.

Fecal eructations and vomiting are likewise important symptoms of gastrojejunocolic fistula. Ten patients gave fecal eructations and 9 vomiting as major complaints. Although fecal eructations and sterco-raceous vomiting are frequently recorded in patients' charts, careful questioning often reveals the regurgitations and vomiting to be of fetid rather than fecal type. In only 5 of our patients was the vomiting definitely fecal. Duration of symptoms due to fistula prior to the patients' admission to the hospital averaged thirteen months. Three patients had symptoms for less than three months and 3 for more than two years (table 5).

TABLE 5.—*Duration of Symptoms of Fistula Prior to Time of Admission*

Time, Months	No. of Cases
Less than 3.....	3
3 to 5.....	4
6 to 11.....	4
12 to 17.....	7
18 to 24.....	1
Over 24.....	3
Average.....	13 mo.

Anemia, with red blood cell counts of 1,500,000 to 3,500,000 and correspondingly low hemoglobin contents, was present in 15 of our patients. The anemias were of both a hypochromic and a macrocytic type. Blood serum protein levels, determined for 2 patients, were found reduced to 5.3 and 6.1 Gm. per cubic centimeters. Similarly low values were reported by Ransom¹ and by Atwater, Butt and Priestley.⁶ Eighty-eight per cent of the patients from the Mayo Clinic had sub-normal values, with an average serum protein level of 4.9 Gm. per hundred cubic centimeters. Other important findings, which commonly are present, are reduction of ascorbic acid and a prolonged clotting time due to disturbed absorption of vitamin K.

4. Barber, R. F., and Madden, J. L.: The Surgical Management of Gastrojejunocolic Fistulas, *Surgery* **22**:657-670, 1947.

5. Renshaw, R. J. F.; Templeton, F. E., and Kiskadden, R. M.: Gastrocolic Fistula, *Gastroenterology* **7**:511-515, 1946.

6. Atwater, J. S.; Butt, H. R., and Priestley, J. T.: Gastrojejunocolic Fistula with Special Reference to Associated Nutritional Disturbances and Certain Surgical Aspects, *Ann. Surg.* **117**:414-426, 1943.

Roentgenologic studies were carried out on all patients, and for 20 a correct diagnosis was made. For the other 2 patients a marginal ulcer was positively diagnosed, but some uncertainty existed concerning the presence of fistulous communication to the colon. Small tracts which permitted only slow passage of barium were later found at operation in both of these patients. As a rule the use of barium enemas is more advantageous in making a diagnosis than administration of a barium meal. Because of the greater rapidity with which the radiopaque material passes from the colon into the stomach and jejunum, it is much more easily visualized at that time than when it is passing more slowly in the opposite direction.

Treatment of gastrojejunocolic fistula is both medical and surgical. Before surgical treatment can be initiated, the acidosis, alkalosis, ketosis, avitaminosis and nutritional imbalances resulting from prolonged diarrhea, vomiting, loss of weight and dehydration must be overcome. In our patients several days to several weeks of treatment were necessary to reestablish as nearly as possible a chemical-physiologic balance. During this time, large doses of vitamins, intravenously administered dextrose and sodium chloride solution, low residue diets, enemas, blood transfusions and chemotherapy were given as indicated. The value of these procedures has previously been demonstrated. Gray and Sharpe⁷ observed a drop in their mortality rates from 61.5 to 27.7 per cent after adoption of a nutrition-restoring preoperative program, and a 28 per cent reduction was reported by Collier.⁸

A variety of technics has been used in the surgical treatment of gastrojejunocolic fistula. Disconnection of the fistula, with restoration of normal continuity, was the operation of choice from the time of Czerny's operation on the first reported gastrojejunocolic fistula in 1903 until recent years. In an attempt to lower operative mortality, exteriorization of the transverse colon at the time of removal of the fistula was carried out by Mason and Baker⁹ in 1931, and in 1935 Lahey and Swinton¹⁰ reported an exclusion operation with an end to side gastrojejunostomy. Allen¹¹ subsequently devised an aseptic technic considered of value, and Findlay¹² utilized the Mikulicz principle by

7. Gray, H. K., and Sharpe, W. S.: Preoperative Management of Gastrojejunocolic Fistula, *Arch. Surg.* **43**:850-857 (Nov.) 1941.

8. Collier, F. A., in discussion on Pfeiffer and Kent.¹⁴

9. Mason, J. T., and Baker, J. W.: Gastrocolic Fistula, *S. Clin. North America* **11**:1097-1099, 1931.

10. Lahey, F. H., and Swinton, N. W.: Gastrojejunal Ulcer and Gastrojejunocolic Fistula, *Surg., Gynec. & Obst.* **61**:599-612, 1935.

11. Allen, A. W.: An Aseptic Technique Applicable to Gastrojejunocolic Fistula, *Surgery* **1**:336-348, 1937.

12. Findlay, F. M.: Treatment of Gastrojejunocolic Fistula by Multiple Stage Operations, *Arch. Surg.* **32**:896-906 (May) 1936.

exteriorizing the transverse colon and the segment of small bowel involved in the fistula. Scrimger¹³ removed the mucosa from a gastric cuff about the fistula, closed muscularis to muscularis and subtotally resected the stomach. Successful employment of a preliminary colostomy involving the ascending loop followed by disconnection of the fistula, with restoration of normal continuity, or preferably subtotal gastric resection was reported by Pfeiffer and Kent¹⁴ in 1939. More recently Marshall¹⁵ modified the Lahey-Swinton technic by using a side to side preliminary ileocolostomy, with a later removal en bloc of the involved area, terminal ileum, cecum, ascending colon and that portion of the transverse colon which lies proximal to the fistula. Jejunojejunostomy and subtotal gastric resection are also carried out as a part of the second stage procedure.

Surgical procedures used in the treatment of our patients are shown in table 6. Because of the likelihood of reactivation of the original ulcer following restoration of normal continuity, gastric resection is undoubt-

TABLE 6.—*Surgical Procedures Used in Treatment of Fistulas*

Operation	No. of Cases
Excision of ulcer, with closure of stomach, jejunum and colon.....	2
Gastroenterostomy, with closure of jejunum and colon.....	5
Gastric resection, with closure of jejunum and colon.....	3
Colostomy—excision of ulcer, reestablishment of normal continuity..	2
Colostomy—gastric resection, enterostomy, reestablishment of normal continuity of colon.....	2

edly the operation of choice. When all factors are evaluated, however, this is not at times a feasible procedure. Since recurrence of ulcer provides a continuous threat when gastric resection is not done, it appeared to us that the effect of vagotomy on patients in whom resection was not performed was worthy of determination. Vagus section, consequently, was performed on 2 patients, whose case histories follow.

CASE 1.—Mr. P. J. B., aged 48, entered the hospital with a history of closure of a perforated duodenal ulcer in 1941. Two years later (1943), because of recurrence of symptoms, a posterior gastroenterostomy had been done. In 1944 a recurrent diarrhea was diagnosed as ulcerative colitis. This lasted only a short time.

Three years later, in 1947, severe diarrhea, epigastric pain, weakness, loss of weight—22 pounds (10 Kg.) in three months—and striking malnutrition developed.

13. Scrimger, F. A. C.: A Technique for the Management of Gastrojejunal Ulcers With or Without Gastrocolic or Jejuno-colic Fistula, *Ann. Surg.* **104**:594-600, 1936.

14. Pfeiffer, D. B., and Kent, E. M.: Value of Preliminary Colostomy in Correction of Gastrojejuno-colic Fistula, *Ann. Surg.* **110**:659-688, 1939.

15. Marshall, S. F.: A Plan for the Surgical Management of Gastrojejuno-colic Fistula, *Ann. Surg.* **121**:620-638, 1945.

Roentgenograms confirmed a diagnosis of gastrojejunal fistula. At operation the area containing the fistula was resected, a new anterior gastroenterostomy was made and the vagus nerves were sectioned.

Follow-up studies made eighteen months later showed the patient to be normal in weight and asymptomatic. No free acid was present in the stomach, as determined by the insulin test, and roentgenograms revealed a functioning gastroenterostomy opening.

CASE 2.—Mr. S. N., aged 51, was admitted to the hospital in 1946 complaining of epigastric pain, recurrent diarrhea, nausea, weakness and loss of weight. A diagnosis of duodenal ulcer had been made in 1920, and four years later a posterior gastroenterostomy was done. Except for a period of approximately six months following operation, he had never been completely free of symptoms. He had been hospitalized for medical management in 1930 and again in 1937.

A diagnosis of gastrojejunal fistula was made and confirmed by roentgen study. After preliminary colostomy and two months of preoperative care the fistulous tract was resected. No evidence of ulcer could be found by careful search, and normal continuity was restored without further surgical treatment.

Eighteen months later, in 1948, the patient returned because of distress from ulcer and occult blood in the stools. He refused gastric resection but finally agreed to a vagotomy. Follow-up studies made six months after operation found him normal in weight, asymptomatic and carrying on his duties as a steel worker. Roentgenograms revealed an adequately functioning gastroenterostomy opening,¹ and the insulin test showed no free acid present in the stomach. The patient stated he was feeling better than at any time since World War I.

Two other patients in our series are likewise of unusual interest. Subsequent to surgical removal of an initial gastrojejunal fistula, a second fistula of the same type developed in each. To our knowledge this complication has not previously been reported. Case histories of these patients follow:

CASE 3.—Mr. P. J., aged 40, was referred to the hospital on Jan. 8, 1927, because of persistent epigastric pain not related to meals or relieved by diet or powders. He was anemic, and occult blood was present in the stools. Fifteen years previously roentgenograms had revealed a duodenal ulcer, and in 1912, after a severe hemorrhage, posterior gastroenterostomy had been performed.

Roentgenograms showed the presence of a gastrojejunal fistula, and at operation a marginal ulcer and the involved area of stomach, jejunum and colon were removed. A new posterior gastroenterostomy was done.

On Nov. 5, 1928, the patient was readmitted complaining of severe abdominal pain, dizziness, weakness and dark red stools. Roentgenograms showed, for the second time, a gastrojejunal fistula. The patient refused surgical treatment and left the hospital. Six months later he was readmitted in a terminal condition, and autopsy confirmed the previous diagnosis¹ of a second gastrojejunal fistula.

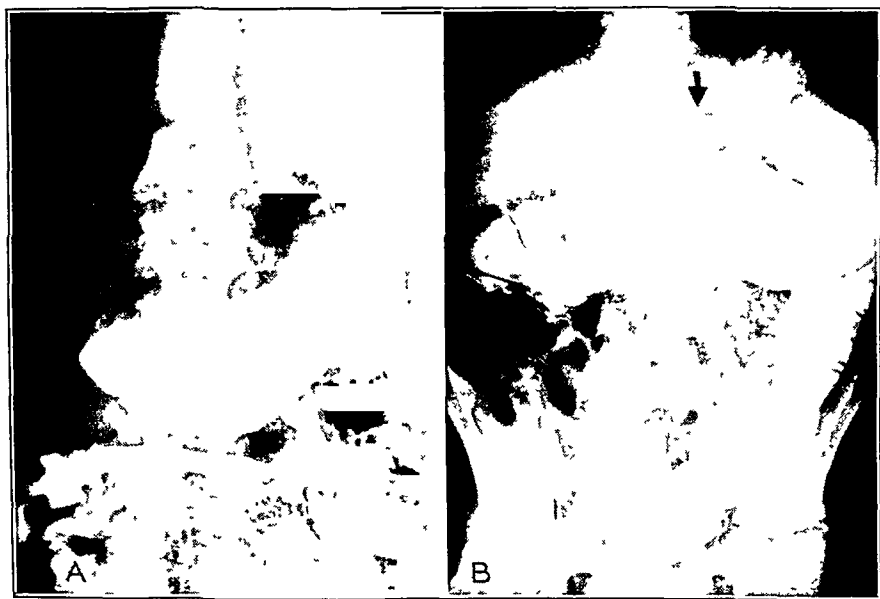
CASE 4.—Mr. J. A., aged 54, entered the hospital in 1918 with a history of epigastric distress relieved by sodium bicarbonate and food. In 1920 a diagnosis of duodenal ulcer was made, and in 1926 a posterior gastroenterostomy was done. From 1930 to 1933 intermittent attacks of epigastric distress had occurred. After these he was fairly free of symptoms for a period of four years.

Severe epigastric pain, loss of weight, nausea and vomiting forced him into the hospital in 1937, and a diagnosis of gastrojejunal fistula made clinically and roentgenologically (figure, A) was confirmed at operation. The enterostomy

opening was closed and normal continuity restored. Three years later a severe hemorrhage occurred from a recurrent ulcer, and at that time a Polya type of gastric resection was carried out.

In 1943 the patient again was admitted because of epigastric pain, loss of weight and vomiting of a soapsuds enema. Roentgenograms (figure, *B*) confirmed a diagnosis of a second gastrojejunocolic fistula. At operation the involved area was removed and an additional portion of the stomach resected. The small bowel was brought anterior to the colon for anastomosis.

Five years later, in 1948, the patient entered the hospital for the fifth time, again complaining of severe epigastric pain. He had vomited, and a large tender mass was palpable beneath the upper portion of the laporotomy scar. At operation an inflamed, thickened, distended gallbladder, adherent to the abdominal incisional scars and surrounding tissues, was found. When interviewed six months later, he was asymptomatic and feeling well.



A, roentgenogram taken after a barium meal showing the first fistulous tract. Rapid passage of fluid from stomach to colon and small bowel was seen by the fluoroscopic examination. *B*, roentgenogram made after a barium enema showing the second fistulous tract. Fluoroscopy revealed rapid passage of opaque fluid from the transverse colon into the stomach and small bowel.

Operative mortality from 14 operations performed during a period of twenty years was 6, or 43 per cent. However, if the patients are divided into those admitted during the first ten years of the study and those admitted during the last ten years, it is found that 5 patients died and 1 survived during the first decade while 1 died and 7 lived of the more recent group—a mortality rate of 12.5 per cent. As pointed out by Barber and Madden,⁴ the dismal prognosis of past years for patients with gastrojejunocolic fistula has recently become much brighter. A summary of 21 recent collected cases, in all of which preliminary colostomy had been performed, shows a death rate of only 4.8 per cent.

Follow-up reports were obtained on 7 of our patients. One patient of the early group, in whom normal continuity was restored, was living and well two years later. In another patient, in whom resection of his marginal ulcer and replacement of the posterior gastroenterostomy opening were carried out, a second ulcer developed, which necessitated gastric resection three years later. A third patient, who underwent gastric resection in 1944, is working and without symptoms. As previously stated in their case histories, both of the patients who were subjected to vagotomy and the patient who had a recurrence of his fistula are doing well. One patient with a recurrent fistula refused surgical treatment and died soon thereafter.

SUMMARY

1. Twenty-two cases of gastrojejunocolic fistula, which occurred as complications of posterior gastroenterostomy performed for duodenal ulcer, are reported.

2. Prominent symptoms present in all cases were uncontrollable diarrhea, loss of weight, abdominal pain, weakness and malnutrition.

3. An average of six years and two months elapsed between the original operation and the onset of symptoms of a fistula. The shortest period was eight months and the longest twenty-two years.

4. Fourteen patients were treated surgically. One stage operations were done on 10 and two stage procedures on 4. Vagotomy was effectively used on 2 patients.

5. Two cases in which a gastrojejunocolic fistula recurred after surgical removal of the initial fistula are included in this series. Development of a second gastrojejunocolic fistula subsequent to removal of a first has not to our knowledge previously been reported.

6. Operative mortality for the entire series was 43 per cent. During the last ten years this was reduced to 12.5 per cent.

DISCUSSION

DR. ARTHUR MARKS, Maywood, Ill.: I should like to mention two reports from the literature which have been published since we started this study. The first was by Mathewson, who in 1947 apparently was the first to report the use of vagotomy in the treatment of this condition. After a first stage Lahey procedure, vagotomy was carried out through the left side of the chest. Subsequently the patient became asymptomatic and gained weight, and gastric analysis showed no free acid present. Therefore, the second stage Lahey procedure up to the present time has not been carried out.

Recently Walters, in a discussion of peptic ulcer, mentioned 4 cases of gastrojejunocolic fistula in which they had used vagotomy. Normal continuity was restored in 1 of these patients and new gastroenterostomies made in 3. This procedure has been mentioned elsewhere, and doubtless other reports of its value soon will be forthcoming.

DR. H. GLENN BELL, San Francisco: May I add 1 more case to the doctor's report of two gastrojejunocolic fistulas? In 1 of our cases the first operation was a mistake. In our state osteopaths have a right to operate. The first operation was done for duodenal ulcer. After the operation was over the patient was told by his physician: "I made a mistake. I made your anastomosis between the stomach and the transverse colon."

It was rather interesting. I saw the man three or four months after that operation and tried to convince him that he should be operated on. He was having no difficulty. You could not show the communication except by retrograde barium enema. He went along for a year and a half, perfectly comfortably and carrying on his work, and then he began having foul eructation and vomiting. He then came in.

We restored the original continuity and did a subtotal resection, and he got along well but was back in a year and a half with another gastrojejunocolic fistula. We had not connected his transverse colon to his stomach. Nevertheless, we had to reoperate and do a further resection. That was some ten years ago, and he has remained perfectly well.

DR. STANLEY E. LAWTON, Chicago: I have nothing further to add except that we observed a similar case, not in our service, in which the colon had mistakenly been anastomosed to the stomach, and subsequently a fistulous tract developed.

PHLEGMONOUS CECITIS

Report of Two Cases

W. L. RIKER, M.D.

R. K. GILCHRIST, M.D.

AND

V. C. DAVID, M.D.

CHICAGO

THE DIAGNOSIS of cecitis or typhilitis was popular until appendicitis became recognized as a pathologic entity. After this it became the general opinion that every case of inflammation of the cecal region was secondary to appendicitis and many authorities denied the existence of primary cecitis as a disease entity.

Gradually more evidence is accumulating that primary inflammation in the cecum, though rare, may occur. Two patients were treated recently who had cecitis of two distinctly different types. The first had a typical circumscribed phlegmon of the cecum characterized by a severe, submucosal inflammation and presented the picture described in the following report.

REPORT OF CASES

CASE 1.—History.—A. G. was a 61 year old Polish housewife who entered the Presbyterian Hospital on Jan. 14, 1948, with the history of recurrent attacks of severe pain in the right upper abdominal quadrant following meals over a period of twenty-three years. Cholecystograms had shown a nonfunctioning gallbladder. The attacks had become so severe that she was admitted for cholecystectomy. There had been no other gastrointestinal symptoms. She had mild dyspnea and occasional substernal pain on exertion and slight orthopnea.

Examination.—The patient was an elderly, obese woman. Her blood pressure was 140 systolic and 94 diastolic, and the heart and lungs seemed normal. Abdominal examination showed only a moderate tenderness below the right costal margin. The hemoglobin content was 14 Gm., the red blood cell count was 4,800,000 and the white blood cell count was 5,800. The urine was normal.

Operation.—The abdomen was opened through a right paramedian incision. The gallbladder was thick walled and filled with stones. The appendix was delivered and found to be slightly enlarged. A firm mass 3 cm. in diameter was felt in the cecal wall near the base of the appendix. It was felt that the mass had enough of the characteristics of carcinoma to make a radical resection necessary.

From the Surgical Department of the Presbyterian Hospital.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 3, 1948.

After cholecystectomy a resection of 6 inches (15 cm.) of the terminal portion of the ileum, the cecum, the ascending colon and a portion of the transverse colon was performed. The ends of the bowel were closed, and a side to side anastomosis was done between the terminal portion of the ileum and the transverse colon.

Pathologic Changes.—There was a firm, discrete, nodular area 4 by 3 by 1 cm. in size in the wall of the cecum at the base of the appendix, partially occluding its lumen. The mucosa over this area was hemorrhagic. Microscopic sections showed an acute and chronic inflammatory process maximal in the submucosal area (fig. 1). There was some ulceration of the mucosa. Edema, fibrosis and infiltration by all types of inflammatory cells could be seen (fig. 2). Eosinophils were especially numerous. The border of the inflammatory process was sharply demarcated. Regional lymph nodes showed only fibrosis and hyperplasia.



Fig. 1.—Section of the cecal wall in case 1 shows that the inflammatory process is confined mainly to the submucosa.

The gallbladder showed severe inflammatory reaction. The appendix, ileum and remainder of the colon were entirely normal.

Postoperative Course.—Because of the lack of preoperative preparation moderate distention and paralytic ileus developed. On the fifth postoperative day the patient suddenly became dyspneic and a rapid irregular pulse developed. Repeated electrocardiograms were suggestive of a coronary occlusion.

Under oxygen therapy and digitalization the patient gradually improved. She was discharged on the twenty-sixth postoperative day, apparently completely recovered. Several stool cultures and examinations for ova and parasites revealed no organisms.

Comment.—This case presents the typical pathologic picture of circumscribed phlegmonous cecitis. Reports of this condition were mainly

confined to the foreign literature until 1943, when Spivack and Busch¹ gathered 35 case reports and added 2 of their own and presented an excellent description of the disease. Since then 3 additional cases have been reported, 1 being somewhat more diffuse in character.²

The cause of this condition is thought to be a bacterial invasion of the submucosa either from superficial mucosal abrasions due to hard fecal masses, foreign bodies or parasite infestation or of hematogenous origin.



Fig. 2.—Higher magnification of the submucosal area in case 1 shows the type of inflammatory reaction.

1. Spivack, A. H., and Busch, I.: Phlegmonous Cecitis: Report of Two Cases and Review of the Literature, *Am. J. Surg.* **61**:54-60 (July) 1943.

2. (a) Meyer, L. M., and Disch, R.: Acute Phlegmonous Cecitis, *Am. J. Surg.* **68**:398-400 (June) 1945. (b) McHardy, G., and Browne, D. C.: Phlegmonous Cecitis, *New Orleans M. & S. J.* **98**:532-533 (June) 1946. (c) Bulmer, J. W.: Phlegmonous Cecitis, *M. Times, New York* **75**:66-70 (March) 1947.

Pathologic Process: The pathologic process is described by Spivack and Busch as

. . . characterized by an irregularly oval or circular area of edema and redness, sharply differentiated from the surrounding normal tissue. The area is frequently covered with thin, grayish-yellow fibrin and feels doughy. Occasionally there is central softening in the mass due to abscess formation or to ulceration of the mucosa. . . . The microscopic picture . . . consists of a profuse exudation of collagen-rich fluid in the submucosa and to a lesser extent in the subserosa. There is an infiltration of numerous polymorphonuclear leucocytes in both these areas. . . . The muscularis and mucosa are involved in the process but to a much lesser degree



Fig 3—Gross specimen from case 2. The appendix is opened to show the thickened wall and adjacent cecal mass.

Diagnosis: The diagnosis is difficult. In almost all the cases in the literature the symptoms simulated those of appendicitis, with pain in the right lower abdominal quadrant, fever and vomiting. A tender mass palpable in the right lower quadrant usually leads to the diagnosis of appendical abscess. However, the presence of a mass with such a short duration of symptoms might suggest this type of cecitis rather than appendical abscess.

The clinical aspects of our case were completely atypical. There were no indications of an inflammatory process in the cecal region.

so that when the mass was discovered at operation it was much more suggestive of an early neoplasm.

Treatment: Since the condition cannot be absolutely differentiated from appendicitis or carcinoma, a laparotomy is always necessary. If the clinical picture and the gross appearance at operation are typical, two courses of treatment are possible.



Fig. 4.—Section of the cecal wall in case 2 shows the great thickening, cellular infiltration and scattered focal granulomas.

1. The abdomen may be closed, with or without removal of the innocuous appendix. The patient is followed carefully while given chemotherapy, subsidence of the mass being observed. Fluoroscopy of the colon will demonstrate the disappearance of the cecal deformity." This

3. Spivack and Busch.¹ Bulmer.^{2c}

method was used in 20 cases, with 1 death due to extension and abscess formation.^{2a}

2. An ileocecal resection can be done. This was performed in 10 cases without mortality. It is certainly the best procedure if the possibility of carcinoma cannot be ruled out.

In the 10 remaining cases partial resections, excision of the involved area or exteriorization was performed. There were 3 deaths in this

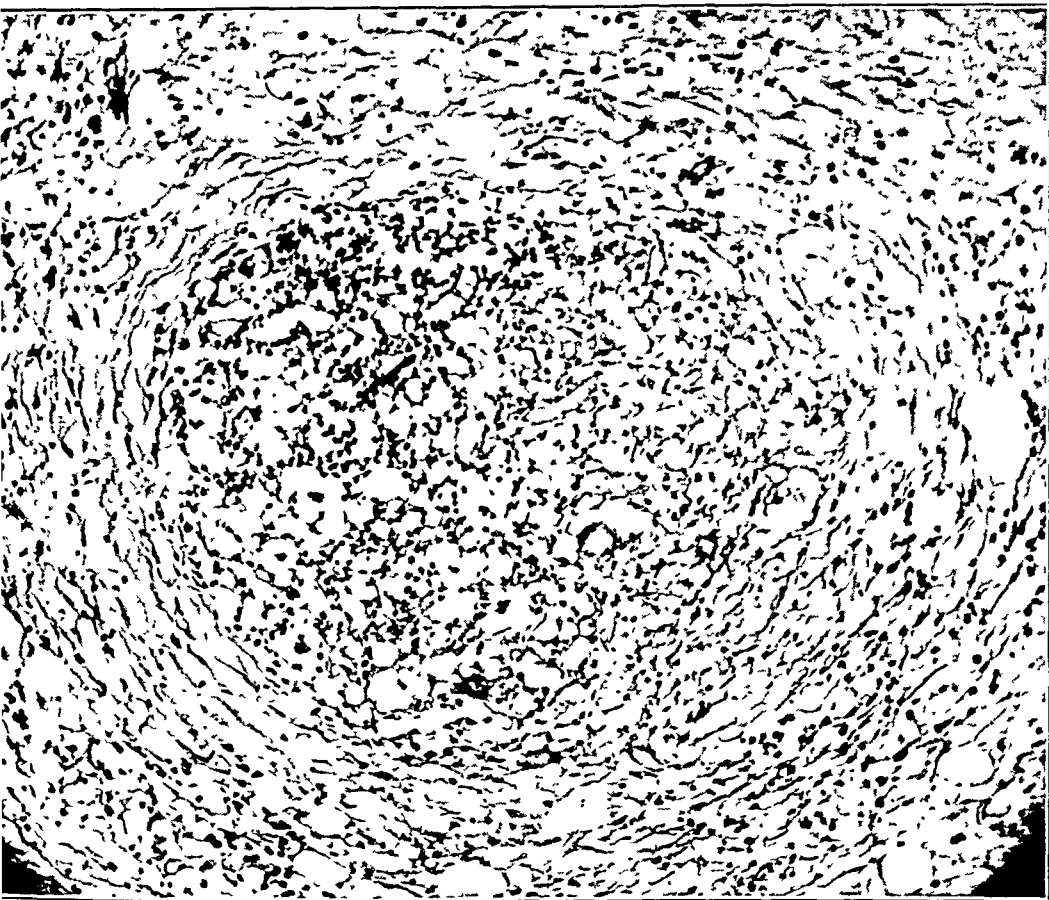


Fig. 5.—Focal granuloma from case 2 showing several giant cells.

group. It would seem that there is no middle course in the treatment of this disease.

In the second case there was a clinical picture similar to circumscribed phlegmonous cecitis but an entirely different pathologic process, most closely resembling a regional enteritis, was found, as will be discussed after the case report.

CASE 2.—History.—E. H., a 37 year old housewife, entered the Presbyterian Hospital on April 7, 1948, with the complaint of pain in the right lower abdominal quadrant of six weeks' duration. Six days prior to her admission the pain increased

in severity and became constant. Anorexia also developed. Previous to this she had been healthy.

Examination revealed a well nourished and well developed woman. There was a tender, movable mass in the right lower quadrant of the abdomen. The temperature was 99.6 F. The hemoglobin content was 15 Gm., the red blood cell count was 4,800,000 and the white blood cell count was 7,900. The urine was normal. The gynecologists made a tentative diagnosis of a twisted ovarian cyst.

Operation.—When the abdomen was opened, the appendix and the adjoining cecum were found to be enlarged into a hard nodular mass. Redness extended a few centimeters up the cecum and along the terminal portion of the ileum. There was great thickening of the mesoappendix and enlargement of the adjacent lymph nodes. Frozen sections taken from the mesentery showed "chronic inflammation."

Removal of the appendix alone would have been impossible, so an ileocecal resection was done. The ends of the colon and ileum were closed, and a side to side anastomosis was performed.

Pathologic Changes.—The appendix and cecum were matted into a hard, irregular mass measuring 5 by 7 by 4 cm. (fig. 3). Their walls were greatly thickened. The cecal mucosa was reddened and thrown up into hypertrophied rugae. Microscopic sections showed ulceration of the mucosa over the involved area. Edema, fibrosis and infiltration with plasma and lymphoid cells extended throughout the muscularis, serosa and mesentery (fig. 4). Scattered through these areas and in the regional lymph nodes were numerous tubercles composed of collections of large epithelioid cells and occasional giant cells (fig. 5). There was little evidence of caseation and no calcification. Sections stained by the Gram, Giemsa and acid-fast methods were carefully searched for organisms. No definite tubercle bacillus could be found. The ileum showed little inflammation.

The diagnosis of regional enteritis involving the cecum and extending into the appendix was thought to be the most probable, although tuberculosis could not be entirely ruled out.

Postoperative Course.—The patient made an excellent recovery and was discharged from the hospital on the thirteenth postoperative day. Her health has remained good. Roentgenograms of her chest and abdomen and intravenous pyelograms were normal.

Comment.—The disease in this case, though clinically simulating circumscribed cecitis, pathologically can be seen to be a distinctly different entity. The diffuse, hyperplastic involvement of the intestine with focal granulomas and giant cells suggests tuberculosis; however, certain features point to a more probable diagnosis of regional or "cicatrizing" enteritis.

Warren and Sommers⁴ recently reported 120 cases of regional enteritis and emphasized that the more chronic forms of this condition are frequently mistaken for "hyperplastic" tuberculosis. Their description of the soggy, leathery induration of the intestinal wall and the thick stiffened mesentery fits closely case 2. Microscopically the pathologic process is identical. Eighty-three per cent of their patients

4. Warren, S., and Sommers, S. C.: Cicatrizing Enteritis as a Pathological Entity, *Am. J. Path.* **24**:475-501 (May) 1948.

had focal granulomas, and in 43 per cent there was giant cell formation. These granulomas differ from those of tuberculous origin in that the architecture is more irregular, no tubercle bacilli can be found, there is no caseation or calcification and the giant cells vary in size and have scalloped edges.

The resection of the involved bowel will probably avoid the usual complications of regional enteritis—obstruction, abscess and fistula formation.

Other types of cecal inflammation may be mentioned. Specific infections include tuberculosis, actinomycosis, blastomycosis and amebiasis. Nonspecific infections aside from the two types presented include solitary ulcers and segmental ulcerative colitis.⁵

SUMMARY

Two cases of cecitis are presented, each representing a different pathologic entity. In 1 case there was a typical circumscribed phlegmon which was apparently asymptomatic and resembled a carcinoma. In the other case there was a more diffuse cecitis which involved the appendix and seemed to represent a form of regional enteritis.

An ileocecal resection was done in each case, with recovery.

Appendicitis so predominates among pathologic processes in the cecal region that other inflammatory processes receive little attention. Nevertheless, phlegmons of the cecum do occur primarily, and one must be prepared to recognize and treat them.

5. Cravati, C. M.: Cecal Granulomas, North Carolina M. J. 7:633-636 (Dec.) 1946.

HIDDEN CARCINOMA OF THE BREAST

HOWARD D. COGSWELL, M.D.

TUCSON, ARIZ.

JACKSON¹ has recently reported 3 cases of carcinoma of the breast in which the physical examination of the breast did not reveal the condition. In each case the complaint on the patient's admission to the hospital was the presence of an enlarged axillary lymph node. A biopsy of the nodes revealed carcinomatosis and was followed by a radical mastectomy. In his first case the mastectomy was not performed until the cancer had become apparent three years and four months after the excision of the axillary node. In the other 2 cases the biopsy was followed in a short time by mastectomy, and small primary carcinomatous lesions were found in both instances.

Jackson stated: "If similar incidences have been previously observed and recorded, a cursory review of the voluminous literature on carcinoma of the breast failed to reveal it." The dearth of such reported cases is possibly indicative of the rarity of the condition, but it may be that reports of such cases have been neglected in the literature and that they are not so rare as seems apparent.

Of late, a similar case has been observed and forms the basis for this report.

REPORT OF A CASE

A woman aged 45 entered the hospital on March 29, 1948, complaining of a mass in her left axilla. About six weeks previous to her admission she had been disturbed by pain radiating down her left arm roughly following the sensory distribution of the radial nerve. Examination by her physician revealed an enlarged node in the left axilla. The patient had recently recovered from what was thought to have been a virus infection of the respiratory tract. The adenopathy was thought possibly to be associated with this infection. In about ten days the neuritis had improved, and the patient believed that the node had diminished in size. Four days before admission the gland suddenly enlarged to the size of a small tangerine and the neuritis reappeared with more intensity than had previously been present. Physical examination showed the node to be tender, hard and not attached to the skin, but it was not freely movable. Careful examination of the

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 3, 1948.

1. Jackson, A. S.: Carcinoma of the Breast in the Absence of Clinical Breast Findings, *Ann. Surg.* **127**:177 (Jan.) 1948.

left breast gave no evidence of tumor or abnormalities. No other demonstrable enlargements of lymph nodes were found elsewhere. Roentgenograms of the chest were normal. The blood count and urine were normal. The serologic test gave a negative reaction.

On March 30, 1948, the node in the left axilla was removed, and it was reported that the frozen section did not reveal any malignant process. Fixed sections, however, showed the architecture of the lymph node destroyed to a large extent by tumor tissue, and the diagnosis of metastatic adenocarcinoma was made. The frozen section had evidently been cut through a necrotic, hemorrhagic section masking the true nature of the tumor (figs. 1 and 2).

Radical excision of the left breast was done on April 5, 1948. The pathologic study of the breast was made by Dr. Louis Hirsch. His report was as follows:



Fig. 1.—Biopsied lymph node showing large central area of necrosis. Gross specimen measured over 2.5 cm. in length.

Gross Changes.—Specimen consists of breast, adjacent muscle and lymphatic tissue. The nipple is not inverted or fixed. There is a small nodule which is situated at the lower border of the breast 7 cm. below the nipple. It measures 9 mm. in diameter (fig. 3). It is stony hard and coarse. The breast tissue elsewhere is coarse, and there appear to be multiple papillomas. These take the form of tiny excrescences which are noted when the breast is incised. There is a small amount of intervening adipose tissue which is lobulated and lipomatous in appearance. Examination of the axillary fat reveals many large lymph nodes, the largest of these measuring 2.5 cm. in diameter. Cut sections show these to be composed, to a large extent, of a yellow caseous material. There is little nodal architecture left.

Microscopic Changes.—(a) Breast (section through tumor): The architecture is disrupted by neoplastic overgrowth of cells. Most of the glands are well formed. There are a few areas which appear definitely malignant; for the most part, however, the section resembles sclerosing adenomatosis (fig. 4). (b) Lymph Nodes:

There are some well formed glands. However, many of the glands show central areas of necrosis. These are bordered by a thick layer of phagocytes, and near the periphery malignant cells are seen.



Fig. 2.—Photomicrograph of biopsied node illustrating the thin rim of metastatic tumor cells and their relationship to necrosis.

Pathologic Diagnosis.—The diagnosis was (1) adenocarcinoma of the breast and (2) metastatic adenocarcinoma of regional nodes.

Postoperative Course.—The patient's postoperative course was complicated by phlebitis of the left brachial vein. The rapid subsidence of pain and edema in the arm following stellate ganglion blocks with procaine hydrochloride was in

accordance with the experience of Hanelin and his co-workers.² She was discharged from the hospital on April 14, 1948. Since this date she has had irradiation and has regained her preoperative weight.

The axillary lymph glands are divided into five groups and vary from twenty to thirty in number. The afferent lymph vessels of these glands drain the arm, the skin and muscles of the anterolateral wall of the body above the level of the umbilicus, the skin and muscles of the

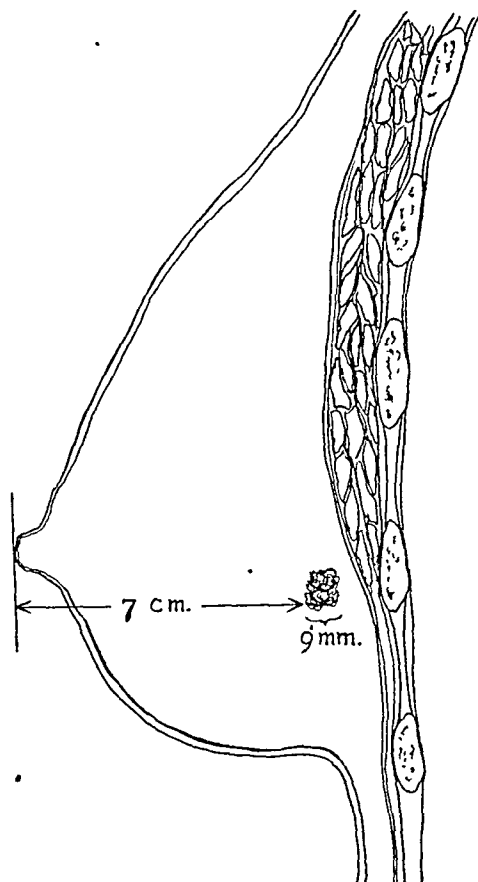


Fig. 3.—Relative size and relationship of tumor to nipple.

dorsal aspect of the trunk, the lower portion of the back of the neck and the central and lateral parts of the mammary gland. It is difficult to understand how metastasis to axillary lymph glands could occur from a primary tumor elsewhere than from the regions drained by the afferent lymph channels. It has occurred, however, and Jackson³ has recently

2. Hanelin, H. A.; Williams, J. M.; Wolfeson, S. M., and Wernick, E. D.: Treatment of Postoperative Swelling of the Arm Following Mastectomy. *Arch. Surg.* 55:723 (Dec.) 1947.

3. Jackson, A. S.: Personal communication to the author

observed a case of metastasis to axillary lymph glands secondary to carcinoma of the liver. It is with some trepidation that, on the basis of biopsy of a lymph node, the recommendation of radical mastectomy is made to the patient after careful examination of the breast reveals no

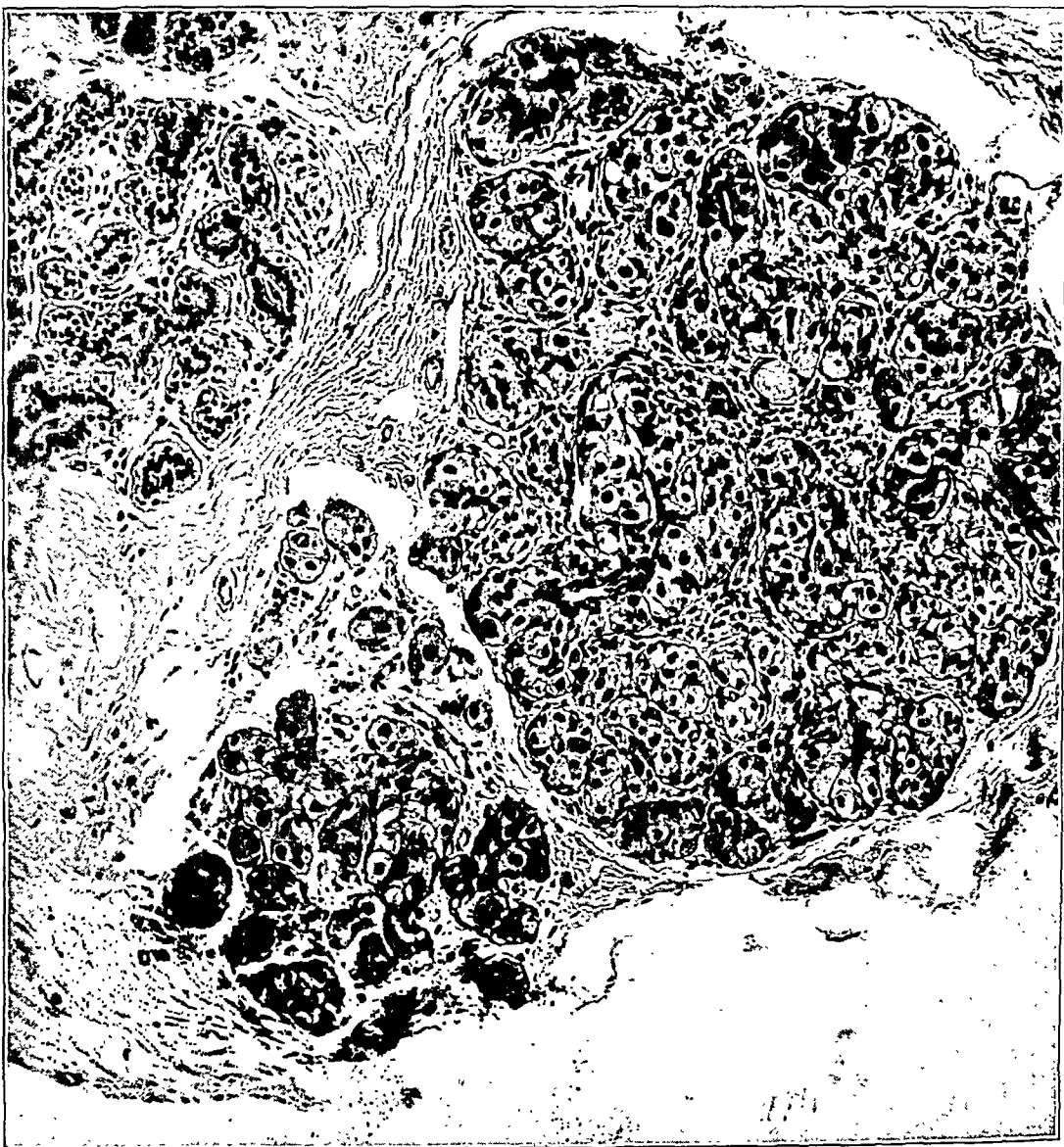


Fig. 4.—Photomicrograph of the breast lesion showing the primary carcinomatous lesion. Grossly this primary site measured 9 cm.

evidence of a tumor. If no other primary site can be determined, however, the operation should be recommended as this interesting and possibly rare type of carcinoma of the breast seems to be similar in its behavior to the papillary adenocarcinoma of the thyroid gland. These

malignant growths of the thyroid are discovered by the presence of "aberrant" tumors in the neck which are secondary to a small, often hidden, primary tumor of the thyroid gland, which acts as a feeder for the spread of malignant cells to the adjacent lymph nodes.

The 3 cases reviewed by Jackson and the report included here emphasize the importance of a thorough palpation of the axillas in examinations of women. "If axillary nodes are found, they should be removed for pathologic examination, and, if found to be malignant, the advisability of a radical breast amputation should be given the most serious consideration."¹

DISCUSSION

DR. ARNOLD S. JACKSON, Madison, Wis.: When one removes an axillary gland and has a report from a pathologist of adenocarcinoma and when observers report the breast normal, it takes a great deal of courage to remove that breast. Three years ago I did not have that courage. The first patient was a sister of an excellent internist, and the pathologist reported that it was either an axillary sweat gland tumor, which Dr. Speed has talked to us about in the past, or a metastatic lesion possibly from the breast.

We decided to observe this patient at three month intervals, which we did for three years and four months, and we finally noted a small lesion in the breast and performed a radical mastectomy. She is still living and apparently is getting along all right.

After the publication of this paper I began to receive communications from men in various parts of the country who had recently observed a similar case, and Dr. Blackburn, who is here from Guys Hospital, told me this afternoon that he has just had a case of this nature. I am sure that all members of this Society have either had a case or will encounter one.

Now I must give you a word of caution. When the second patient came along, and at least twelve men had examined the breast and pronounced it normal, I said to the woman, "If you were my wife, I would remove that breast." We did remove it, and on turning it over we noted a lesion about the size of the head of a match, which proved to be the primary source of the carcinoma.

Not long ago a woman about 48 years of age, on whom I had done an operation on the thyroid for Hashimoto's disease six months before, came back complaining of a painful node outside the breast near the sternum. Foolishly, I paid no attention to it at first because the woman was in the menopause and was a little neurotic. Some weeks later I removed it, and it was pronounced metastatic carcinoma. Shortly thereafter enlargement of axillary glands developed; I removed the glands, and they were pronounced carcinomatous.

I then consulted the man who I believe is the top pathologist of the country. We talked it over, and I said, "Do you think this could have been from the thyroid? Was it a malignant process instead of Hashimoto's disease?" He made a careful study and said no.

In view of the other 2 cases we then decided that in justice to the woman we should remove the breast. We did a simple mastectomy, and the breast was pronounced normal. Six months later the woman died, apparently of carcinoma primary in the liver. At no time were there clinical signs of carcinoma of the liver. There was no jaundice.

DR. HARRY B. ZIMMERMANN, St. Paul: Apropos of Dr. Cogswell's paper, I had an interesting experience not long ago. A 53 year old woman was

referred to me because she had a serous discharge from one nipple. Physical examination of the breast showed it to be entirely normal—both breasts were exactly the same, with no evidences of tumor or induration.

Because I had recently acquired the fixing solution for the Papanicolaou technic, I made a smear from the nipple secretion and received a report from the pathologist that the smear showed definite cancer cells. After consultation with the pathologist it was decided to remove the breast. This was done; serial sections were made through it and an area found that might have been interpreted as a cancerous infiltration, although no palpable tumor was present. On histologic study this area proved to be cancer. A radical operation was done, and in the axillary contents several metastatic nodes were found.

This was such a spectacular experience that I shall continue using the Papanicolaou technic in similar cases.

DR. HERBERT H. DAVIS, Omaha: I am much interested in this paper, especially so because of a similar case that I have encountered. Mrs. M. O. S., aged 75, came to me on Nov. 16, 1943, because of a lump in the right axilla which she had first noticed in April. She stated that it had not changed in size and that there was slight soreness in it. She had lost 13 pounds (5.9 Kg.), her weight decreasing from 125 to 112 pounds (56.7 to 50.8 Kg.) in that six months. Examination revealed a subcutaneous nodule approximately 1.5 cm. in diameter in the central portion of the right axilla. It was well encapsulated and freely movable. Her breasts were rather small. I examined them both carefully and absolutely no tumor was palpable. I advised excision and biopsy of the axillary lump. One week later I excised this lymph node. It was firm, perfectly encapsulated and easily enucleated. No other enlarged lymph nodes were found. Dr. Charles Baker's pathologic report stated: "Grossly the node is enlarged (2 by 2 by 1 cm.) and is firm. Sections showed scattered through the node highly malignant carcinoma cells. There is practically no differentiation. The cells are large and have large nuclei, and there are many mitotic figures. In my opinion, however, this is most likely an adenocarcinoma, and the breast is the most likely site of the primary tumor. The diagnosis is grade 4 adenocarcinoma in lymph node."

The patient wished to go south for the winter, so I referred her to the Ochsner Clinic for more study hoping that the primary carcinoma would be found. The physicians saw her several times and also were unable to find any primary growth. They gave her a course of high voltage roentgen ray therapy to the right axilla and to a chain of slightly enlarged lymph nodes in the left side of the neck. She was also studied that winter by Dr. George W. Owen and Dr. W. R. Bethea, both of Jackson, Miss. They found a firm mass just posterior to the left tonsil and in the nasopharynx. They thought that this might be the primary growth and gave roentgen ray therapy to this area. No biopsy was made from it, however. Nothing abnormal was made out in the breast either at the Ochsner Clinic or at Jackson, Miss.

Early in July 1944, which was nine months after I had done the biopsy of the axillary node and sixteen months after she had first discovered the enlarged axillary node, she noticed a small lump in the right breast. On examination I noted that her breasts were extremely small and atrophic. In the peripheral zone of the right breast laterally at the level of the nipple was an extremely small, freely movable lump 8 mm. in diameter, which was well encapsulated and not adherent to the skin or fascia. I removed this for biopsy, and Dr. Baker, on immediate frozen section, pronounced it grade 4 carcinoma. Therefore, I performed radical excision of the right breast. In so doing, I found two small

central axillary nodes, each about 6 or 7 mm. in diameter. They were about 2 cm. inferior to the axillary vein. Microscopically, these nodes were replaced by grade 4 adenocarcinoma.

A month later at home she had a rather serious heart attack. However, she survived that and several less serious ones since. At the present time she is still living, at the age of 80, and I understand she is in surprisingly good health.

Regarding Dr. Zimmermann's remarks, eight or ten years ago a woman in her sixties appeared with a complaint of recent watery discharge from the left nipple. I palpated carefully and could find no lumps. At her age it was unusual to have that sort of thing. It was not bloody. I started checking. In Cheatle and Cutler's book there is a page devoted to this, in which they reported on a similar patient. They did not think that the discharge meant anything but much to their chagrin the woman died of carcinoma of the breast. They had 3 other patients with similar findings, and 2 of them turned out to have carcinomas.

I quoted this to my patient and did a simple mastectomy because we did not know where to look for biopsy material. In the section we found carcinoma, so we did a radical mastectomy.

DR. W. H. GATCH, Indianapolis: I should like to state what I think is the proper way to examine a breast for cancer. If you slice it at random, as is often done, you will miss these small cancers. We have found the following method effective. Fix the specimen in formaldehyde, then slice it with an ordinary meat slicer, in slices not more than $\frac{1}{8}$ inch (0.32 cm.) thick. Put each of these on a board and examine with a magnifying glass under good light. Make sections of every suspicious piece.

I have been especially interested in that technic in the examination of breasts removed because of a bloody discharge from the nipple. We have discovered in this way some extremely small cancers.

I have seen cases like that reported by Dr. Cogswell. I was once called to a hospital to see a woman who was paralyzed from the shoulders down. Roentgenograms showed that her spine was riddled with metastasis. Her breasts were small, flat and entirely free of lumps. I got, finally, a history that she had had a small tumor of the breast a year before, treated with roentgen rays. I presume it was one of the 12 per cent which are radiosensitive.

What Dr. Cogswell has told us about cancer of the breast can occur in cancer almost anywhere. I recently had this hair-raising experience. A man came to me with the complaint of gallstones. He had had a couple of attacks. He did have gallstones, and we took out his gallbladder; I happened to feel along the top of the liver, and there I discovered a dimple. I thought I could feel something deep under it. Fortunately I cut down through the liver for about half an inch (1.27 cm.) and took out a little nodule, which proved to be cancerous. I then searched everywhere inside the abdomen but could not find a sign of tumor anywhere. In four months that man was dead of abdominal carcinomatosis.

With all the rumpus that is being raised about cancer, one subject has been singularly neglected, and that is a study of the natural history of cancer. What happens to cancer when it is not treated at all? One recent report on the progress of cancer control stated that on the average a patient with cancer of the breast dies two years after the appearance of the tumor. I believe that this is utterly false. I have under observation a woman who has a cancer of the breast which appeared twenty-five years ago. A fungating mass of cancer as big as her head replaces her right breast. The right side of her chest is entirely filled by cancer. Despite all this she is still in a fairly good state of health.

To evaluate the results of treatment of cancer we need a thoroughgoing scientific study of what happens to cancer when it is untreated.

DR. GUY BLACKBURN, London, England: My prime purpose in rising to transgress on your time is to thank you for the hospitality you have kindly extended to me through my friend Warren Cole and for the perfectly wonderful time I am having here. I think the reason that this so-called hidden carcinoma of the breast has not been well reported in the literature is a relatively simple one, and one does not have to look far to appreciate it. The reason (and I speak from experience of a case that Dr. Jackson referred to) is that the surgeon is apologetic to the patient and to himself for having made this error. He likes to conceal it, and he may confess it to one of his surgical colleagues over the English equivalent of a highball.

The patient that I saw should have been operated on and would have been operated on a month before she was had I appreciated this fact and had I realized what I think should like to teach students now, namely, that a metastatic axillary gland should be considered a metastasis from a primary carcinoma of the breast until one has removed the breast and proved that it contains no carcinoma.

I should like to record a similar case in which operation had been performed by one of my senior colleagues, who confessed to me in the later hours of the evening, after an excellent dinner (and we have those occasionally, you know). He told me of a woman of some 60 years of age who had such an axillary gland, and who was, may I say, old fashioned. He removed the axillary gland. The pathologic report came back reading, "squamous cell carcinoma." He advised her to have a radical amputation of the breast. She declined politely for successive visits over two or three years, and for the past ten years he has received twice a year, ever since the beginning of the war, a package in the post containing a dozen eggs. I need hardly remind you that those are not subject to income tax.

DR. E. P. COLEMAN, Canton, Ill.: I should like to report 2 cases because of the unusual location of metastasis. Twenty years ago I saw a woman, then 55 years of age, who had attended a talk on cancer of the breast. She came away much impressed and saw me shortly thereafter, feeling sure she had cancer of the right breast. She was emaciated and nervous and had atrophic breasts. She had almost no mammary tissue at all. The thing she was most concerned about was a lipoma, smaller than a pigeon's egg in size, in front of the right mammary gland, which she had had for ten or twelve years. It had never bothered her, but she had heard that talk and had become conscious of it.

I thought I would reassure her, because she was unduly alarmed. I examined the breasts carefully and found nothing. As a matter of fact, there was very little to examine. She was reassured and went away. The next week she came back. Was I sure it was not cancer? I was. She returned the next week. She did that for six or seven weeks. Finally I said to her, "We will remove that tumor tomorrow, not so much to get rid of it but to get rid of your apprehension."

I took it out the following day; it was a small, normal-appearing lipoma, a thing we called normal, but in the center of it was a small nodule about the size of a grain of wheat. The pathologist reported it adenocarcinoma.

As an Irish friend once remarked, "I had to eat my words." A radical removal of the breast was done, and just back of the nipple was a small nodule about the size of a pea, which was the primary cancer. The woman has had no recurrence and is still living. I have since removed part of the colon for a cancer of

the sigmoid, and she is just now out of the hospital after having had a resection for cancer of the stomach. There is no connection between the three, microscopically.

The second case involved a woman six and a half years ago, aged about 50 at that time, who had a lump in her neck just below the ear. It was apparently a lymph gland, hard but movable. I removed it, and it was reported as being adenocarcinoma. The pathologist said it was probably primary in the breast.

This woman was rather obese. I examined the breasts carefully on several occasions but could find nothing. Finally, looking her over, I noticed that the right nipple was somewhat irregular, almost wartlike in appearance, and was informed that it had always been that way. I removed it just to see what it was, and there was apparently the primary growth. It, too, was adenocarcinoma, of the same type, apparently, as was the gland in the neck. Because this had gone through the lymphatic vessels to the top of the neck, it seemed futile to do a radical mastectomy. She was given roentgen ray treatment; no further operation was done, and she has had no recurrence to date. It will come some time, I am sure; when, I do not know.

DR. WARREN H. COLE, Chicago: Before we close the discussion I should like to call on Dr. Powell. He is too bashful to come up voluntarily to close this discussion.

DR. CUTHBERT POWELL, Denver: I want to report a similar case of a woman aged 63 who came to our office in September 1946 complaining of a small nodule in the right axilla. She was seen by one of my associates, who asked me to examine her. The nodule was freely movable, not adherent anywhere. Absolutely nothing could be found in the breast. However, I advised removal of the nodule. It was reported as carcinoma. The breast was removed, and a carcinoma was found. There has been no evidence of any trouble since then, and that was more than two years ago, so far as the breast is concerned.

She came in on July 20 of this year with an ulcerated area in the right labia minora, which proved to be a squamous cell carcinoma, and vulvectomy was done. This woman had a sister with a carcinoma of the breast which was removed by me two years ago.

DR. H. D. COGSWELL, Tucson, Ariz.: I want to thank the discussers. I believe the credit for this recognition goes to Dr. Jackson. His article came out last January, emphasizing this hidden tumor.

EFFECTS ON THE BREAST OF REMOVAL OF THE NIPPLE OR SEVERING OF THE DUCTS

HERBERT H. DAVIS, M.D.

OMAHA

IS IT dangerous to remove a nipple and leave the glandular tissue of the breast without any duct opening to the exterior for drainage of secretions? What will happen if pregnancy and lactation occur later? Will stasis in the ducts and acini produce chronic inflammation, cysts or cancer? Obstruction of the lactiferous ducts in the nipple produced by tying them off or burning them has been used in mice and rats to produce carcinoma experimentally. On the other hand, most textbooks, in discussing lesions of the nipple, advise simple removal of that structure, but none of them state whether there is any danger regarding inflammation, galactocoele or carcinoma developing later in the breast.

EXPERIMENTS ON ANIMALS

An evaluation of the effect of one type of chronic irritation—milk stagnation—on the incidence of mammary carcinoma has been attempted experimentally in mice. Bagg¹ ligated the mammary ducts on one side in pregnant animals of a strain in which carcinoma of the breast normally developed in about 5 per cent. On the side ligated marked stasis of the mammary ducts developed, with a considerable amount of decomposed, stagnated and probably chemically altered milk, which was sufficiently irritating to cause considerable disturbance within the breast. Only a small number of operations were done, but tumors developed in the breast in which the ducts had been ligated in 2 of the first animals operated on.

Bogen² similarly ligated the mammary ducts of 18 female mice, in 6 of which mammary cancer developed, while 18 normal breeding controls died without tumors.

Fekete and Green³ felt that these investigations were inconclusive because of the small number of animals in each, the possible operative

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 3, 1948.

1. Bagg, H. J.: The Functional Activity of the Breast in Relation to Mammary Carcinoma in Mice, *Proc. Soc. Exper. Biol. & Med.* **22**:419-421, 1925.

2. Bogen, E.: The Cause of Breast Cancer, *Am. J. Pub. Health* **25**:245-250 (March) 1935.

3. Fekete, E., and Green, C. V.: The Influence of Complete Blockage of the Nipple on the Incidence and Location of Spontaneous Mammary Tumors in Mice, *Am. J. Cancer* **27**:513-515 (July) 1936.

injury to mature glands and the low normal incidence of tumor together with the unknown genetic constitution of the mice in Bogen's experiments, which made an adequate control difficult. They first used a strain of mice in which carcinoma of the breast develops in over 80 per cent of the females with a normal reproductive history. At 10 days of age, while the mammary glands were in an undeveloped condition, the five nipples on the right side were touched with a fine red-hot wire to seal them permanently without affecting the development of the glands. At the age of about a month, the females were allowed to breed normally. Of the 49 female mice so treated, mammary gland carcinoma developed in 40, which was about the normal rate for that strain. The tumors were on the occluded side only in 22, or 55 per cent, while in but 3, or 7.5 per cent, the tumor developed on the untreated side only. In the remaining 15, or 37.5 per cent, carcinoma appeared on both sides.

They then tested whether stagnation itself can overcome a hereditary influence unfavorable to the formation of tumors. They did similar experiments in a strain in which mammary cancer normally appeared in far less than 1 per cent of the breeding females. Of these 43 mice, in not 1 was a tumor observed.

Bagg and Hagopian⁴ reported that rapid breeding and prevention of suckling resulted in cancer of the breast in 4 of 29 rats, or 14 per cent.

The investigations of Bagg, Bogen, Fekete and Green and of Bagg and Hagopian have shown that in mice and rats the presence of stasis due to retention of secretions within the ducts as a result of nonsuckling of the young is a prominent feature in causing the development of mammary carcinoma. In addition to the presence of internal factors of a hormonal nature, it is probable that the chemical irritation of retained mammary gland secretions may bear a causative relation to tumors of the mammary gland in female mice and rats.

CLINICAL EXPERIENCES

Adair and Bagg⁵ and later Adair⁶ made a clinical study of the relation between stasis of the secretions of the female breast and the development of mammary carcinoma. Adair analyzed a series of 200 consecutive cases of women suffering from carcinoma of the breast.

4. Bagg, H. J., and Hagopian, F.: The Functional Activity of the Mammary Gland of the Rat in Relation to Mammary Carcinoma, *Am. J. Cancer* **35**:175-187 (Feb.) 1939.

5. Adair, F. E., and Bagg, H. J.: Breast Stasis as the Cause of Mammary Cancer, *Internat. Clin.* **4**:19-26 (Dec.) 1925.

6. Adair, F. E.: Etiological Factors of Mammary Cancer in Two Hundred Women, *New York State J. Med.* **34**:61-68 (Jan. 15) 1934.

In 74 of these the normal breast function had never been established. He cited 1 of these who had undergone five operations on the breast. The first operation occurred at 16 years of age, when a fibrous tumor the size of a hen's egg was removed. The patient was later operated on at the ages of 30, 33 and again at 40 years, at which time she was found to have a carcinoma. Adair felt that numerous surgical injuries produced damage to the duct, fibrosis and stagnation peripheral to the scar. One hundred and twenty-six of the patients had borne children. Of these, only 17 gave an absolutely normal nursing history. One of these patients bore 19 children, including three pairs of twins. All were fed from a bottle. The first child was born when the mother was but 16 years of age. By the time she was 44 years old, her mammary cancer was well developed. Adair felt that stagnation of milk played an extremely important part. In this group of patients a large volume of milk was found within the mammary system. Millions of newly formed lining cells eventually desquamated to lie free within the lumen and underwent disintegration and became a source of chemical irritation.

The 126 mothers bore 386 children and had 172 miscarriages. Adair was of the opinion that miscarriage or abortion was exactly the same as a pregnancy as far as the breast was concerned, as it causes hypertrophy and the production of milk. This proportion of miscarriages is much higher than usual, as shown by other authors who have studied the frequency of miscarriage.

Adair studied 100 control patients in whom carcinoma did not develop and was struck by the complete lack of unusual incidence relating to the nursing history and of such conditions as abscess formation, inverted nipple, caked breasts and miscarriage. Of these patients, 78 had borne children, and there were only 18 miscarriages or abortions, which is about the usual figure.

Adair discussed conditions which can cause stagnation in the breast. It may be due, as stated before, to improper nursing, to stopping it too soon, to frequent pregnancies or to miscarriage or abortion. Not associated with pregnancy, the ducts may be obstructed by localized outgrowth of the lining epithelium or by a change in the nipple, such as inversion, valve condition, flat nipple or ulcerated nipple. There may be a fibrous scar across the duct resulting from an incision for abscess or a contracted scar secondary to a traumatic hematoma. A cyst may cause obstruction. A plug of desquamated lining cells may cause obstruction of the nipple, resulting in inflammatory reaction. Adair concluded that his clinical study corroborated the experimental evidence in animals that stagnation in the mammary ducts seemed to increase the incidence of carcinoma of the breast.

A pertinent article appeared recently by Tice, Dockerty and Harrington⁷ on comedomastitis, a disease of the breast characterized by dilatation of the lactiferous ducts, which are distended with inspissated grumous material that may be expressed when the duct is cut, much as comedos are expressed from ordinary blackheads. It is a disease of the large ducts, about which are aggregates of wandering cells, lymphocytes and plasma cells. This was a study of the cases at the Mayo Clinic in the years 1925 to 1942, 185 patients being treated by local mastectomy and 19 by local mammary resection. The nipple was found to be abnormal in 31 of these, with retraction or inversion in 28 and inflammation in 3. In 1 the nipple had been surgically removed previously. Abnormalities of lactation were noted in 10.4 per cent of the breasts, and in more than half of these advanced disease was noted. It was found that 23 of the breasts contained concurrent papilloma and 18 contained carcinoma. Breasts which contained cysts or apocrine epithelium or both formed a large majority of the cancerous group. The possibility that most carcinomas associated with comedomastitis arise from the ductal system as comedocarcinoma was suggested by the finding of comedocarcinoma in 5 cases and comedo areas in 5 of the infiltrating growths. The authors concluded that comedomastitis usually is associated with chronic cystic mastitis, which may overshadow it clinically, and also that plasma cell mastitis is probably a form of comedomastitis. They felt that neoplasia, although occasionally occurring in the same breast, is probably not related to comedomastitis etiologically. However, by simple obstruction of the mammary ducts, such neoplastic changes may at times produce comedomastitis.

The following case is the basis for this article:

Mrs. G. C. A. was first seen by me in 1932 at the age of 23. She had had a milky secretion from the left nipple and a raw area on or around the nipple since the age of 6 or 7. On examination, a weeping reddened surface covered practically the entire nipple, which was about four times the normal size. There was no induration. The breasts were small, and there were no lumps felt beneath the nipples or in any part. Sir Lenthal Cheatle saw the patient with me. He advised excision of the nipple even though he or none of us had been able to make a diagnosis. In 1933 I did a local resection of the left nipple. After this she had no disturbance in the breast. Since then she has had two children, a daughter born in 1936 and a son in 1942. During the pregnancies there were no differences noted between the two breasts. At lactation both breasts enlarged normally. She tried to nurse from the right breast, but it had an inverted nipple so she could not. The right breast was pumped twice a day for a week. Both dried up equally in two weeks. She used camphorated oil on them. I last saw her on Nov. 10, 1948, fifteen years after the thelectomy, when she was 39 years of age. For the previous two weeks she had been complaining of occasional slight shooting pain in the outer part of

7. Tice, G. I.; Dockerty, M. B., and Harrington, S. W.: Comedomastitis, Surg., Gynec. & Obst. **87**:525-540 (Nov.) 1948.

the right breast, which was not the one operated on. On physical examination both breasts were rather small but exactly the same size and consistency. Nothing abnormal was felt in either one. There were no lumps, no increased nodularity and no tenderness. In the left breast was a transverse scar replacing the nipple.

This patient, in the fifteen years following thelectomy, has noticed no abnormal changes in the breast in which there is no connection of the ducts to the exterior.

In the excision of benign tumors and cysts from central and intermediate zones of the breasts, the mammary ducts are not infrequently severed or excised. This may happen even when the mass is several centimeters from the nipple if, in the procedure, the mass is pulled on so that it draws the tissue from beneath the nipple into the wound. I, therefore, have made a study of 30 cases of cysts and benign tumors centrally located in which I am sure I cut these ducts in the removal of the mass. Those in which the ducts beneath the nipple were not cut across are not included. The patients were operated on between 1931 and 1946. They varied in age from 28 to 68. In 20 the right breast and in 10 the left breast was involved. Of these, 25 have been heard from within the last month. One has died of unrelated causes. Of the remaining 24, 22 have had no trouble with the breast operated on. One of these, operated on in 1936, at the age of 31, has had three children since. In 1947, after weaning her youngest baby, a small galactocele developed in the opposite breast. The involved breast caused no trouble.

Of the other 2, 1 has had three children since operation and nursed them without trouble, but she wrote that she has had a small lump for three years in the breast operated on, which is not enlarging. The other woman, operated on three years ago at the age of 41, has had some pain in the breast. She thought that a lump appeared, but it disappeared again.

In none of these patients has carcinoma developed. However, this does not prove that it might not occur in the future. This series is too small and far too short a period is involved to be conclusive.

Except for 1 case reported by Tice, Dockerty and Harrington,⁷ I have never been able to find any clinical reports of carcinoma of the breast arising after excision of the nipple or severing or excision of the mammary ducts beneath the nipple in the removal of a centrally located benign tumor or cyst. In the performance of mammoplasty for hypertrophied or pendulous breasts the blocking of ducts must be frequent. Some surgeons, such as Max Thorek, remove the nipple and areola and place them in a higher area as free grafts in this procedure. The mammary ducts remaining have no communication with the surface. There are no reports of carcinoma following these mammoplasties.

CONCLUSIONS

Experiments on mice and rats give the impression that ligation or closing of the nipple by cautery may cause the development of carcinoma in the underlying breast. However, many of these experiments were on strains in which the incidence of cancer is high.

There is evidence in the literature that obstruction at the nipple in human beings may cause stagnation, chronic inflammation and comedomastitis. Definite proof that carcinoma may result is lacking.

A patient is reported on who in fifteen years following thelectomy has had two children and has had no trouble whatsoever with the breast.

A follow-up study was made on 24 patients in whom the ducts beneath the nipple were excised in the removal of benign tumors or cysts. In none of them has carcinoma developed.

No definite conclusions can be made as to the danger of removal of the nipple or severing of the mammary ducts in human beings. The question has never been answered satisfactorily, and it is hoped that this discussion will lead to interest in the problem.

DISCUSSION

DR. ERWIN R. SCHMIDT, Madison, Wis.: Thelectomy may seem to be a trivial matter. The case described in the paper was discussed with the author fifteen years ago when I visited him. The results of such a procedure were unknown. While incisions in the breast have been done for a long time and no untoward results seen or reported, what would result from a complete excision of the nipple was indefinite. Reasoning from pathologic pictures supposed to be due to obstruction of the ducts and from various histologic pictures presented in cystic mastitis of the breast came to mind. What would happen if the patient became pregnant? Would a parenchymatous type of inflammation (caked breast) develop? It would be impossible to reduce the tension by either artificial or natural means. These were some of the questions we asked ourselves. Since then the pancreatic ducts have been ligated with little residual effect on the physiology of digestion. Therefore it seemed worth while to follow this patient for a number of years to see if some of these questions could be answered.

There are accessory breasts and breast tissue. In the upper outer quadrant of the breast, extending into the axilla, breast tissue is found which may be connected to the breast or may not. This situation often brings up the question of a malignant growth. This tissue, whether connected or not to the main breast tissue, seems to get along all right. Suggested for restriction of physiologic activity is the use of stilbestrol soon after delivery.

It is a worth while observation, for in the literature there is little about this condition, and the personal experience of my colleagues and myself is practically nil.

DR. S. W. HARRINGTON, Rochester, Minn.: I have been very much interested in Dr. Davis' presentation of the subsequent effects on the breast following the removal of the nipple or severing of the ducts during local excision of tumors, and I agree with his conclusions that there is no definite evidence to indicate that surgical procedures for benign lesions which require removal of the nipple or

severing of the ducts have been followed by malignant disease. I have seen cancer of the breast occur in patients who have had a plastic operation for pendulous breasts. This is a rare occurrence, and I do not believe it is due to the plastic operative procedure. I think that cancer would have developed whether or not the plastic procedure had been done, but it is unfortunate that the procedure masks the malignant process, so that the diagnosis is not established until it is well advanced.

Some years ago I followed a series of 200 patients who had been operated on for benign lesions, particularly those in whom the lesion was found to be Schimmelbusch disease, which is essentially a proliferative type of mastitis. Some pathologists consider this type of mastitis as a precancerous condition, so I made a study comparing the results obtained in patients who underwent simple mastectomy with those in patients in whom local excision was performed. I was unable to find that any patient had returned to our clinic or had been operated on elsewhere for a malignant growth of the breast.

This is an important subject which Dr. Davis has brought before us because of the necessity of removing many benign lesions in order to rule out the possibility of a malignant lesion. If there were a possibility of these local excisions being followed by a malignant disease, it would present a definite hazard. In view of the great number of patients who have had local excision of tumors performed for diagnosis, during which time the ducts must be excised in many instances, if malignant disease were to follow this procedure, it would be noted in a relatively high percentage of patients. I believe that Dr. Davis' presentation shows that local excision of breast tissue is not a hazard and that all tumors in which there is any question regarding the possibility of malignancy should be removed for diagnosis.

MEDIASTINAL TUMORS

A. R. CURRERI, M.D.

AND

J. W. GALE, M.D.

MADISON, WIS.

ONLY in the past twenty years has it been possible to treat mediastinal tumors successfully. Before that the rarity of the tumors and the difficulty of accurate diagnosis, plus the lack of properly developed surgical technic, caused the mediastinum to be considered unapproachable, surgically speaking. Since symptoms were not alarming, except in cases of advanced malignant lymphomas, therapy, if any, consisted solely of irradiation. No attempt was made to determine either the type of tumor or its sensitivity to radiation. Indeed, exploration was considered only in instances in which alarming complications such as tracheal obstruction, bronchial perforation or secondary infection forced the physician to exhibit more than passive interest.

Unquestionably the rapid advances in the field of thoracic surgery and the routine use of roentgenograms of the chest have completely changed the physician's attitude toward these tumors. They certainly occur more frequently than it was formerly believed. Blades,¹ in presenting a collective review from five Army thoracic centers,² reported exploration of one hundred and nine mediastinal tumors, exclusive of the malignant lymphomas, over a three year period. At the Wisconsin General Hospital only fifteen nonlymphomatous mediastinal tumors were diagnosed for the thirteen year period of 1927 to 1940, whereas thirty-seven have been operated on since 1940. These explorations not only resulted in a cure of all the benign lesions, but, more important, they materially aided in the establishment of a differential diagnosis by correlating the roentgenologic observations with the surgical and pathologic findings. At present it is possible, by combining clinical and roentgenologic findings, to diagnose the tumor in approximately 80 per cent of the cases preoperatively.

From the Department of Surgery, University of Wisconsin Medical School.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 3, 1948.

1. Blades, B.: Mediastinal Tumors, *Ann. Surg.* **123**:749 (May) 1946.

2. Baxter General Hospital, Spokane, Wash.; Brooke General Hospital, San Antonio, Texas; Fitzsimmons General Hospital, Denver; Kennedy General Hospital, Memphis, Tenn., and Walter Reed General Hospital, Washington, D. C.

Mediastinal tumors per se do not provoke symptoms. Symptoms are a sequel to complications, and therefore considerable variability may be anticipated, ranging from no symptoms at all to those due to any intrathoracic lesion. Usually symptoms are related to pressure on adjacent structures such as the bronchus, esophagus or nerves. Thus, when present, the most common symptoms are pressure, dyspnea, cough and pain. In rare instances cysts may perforate into adjoining viscera, creating considerable expectoration and becoming secondarily infected.

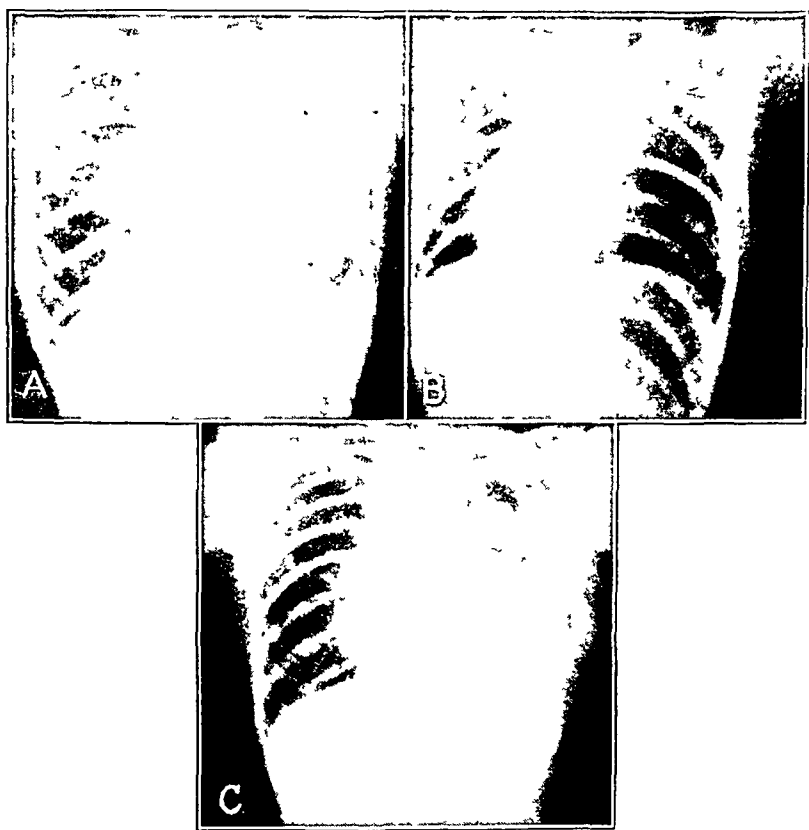


Fig 1—Benign teratoma attaining great size without manifesting symptoms. A, preoperative roentgenogram; B, two days after resection, C, three months later, showing pulmonary expansion and elevated diaphragm.

Benign tumors may attain great size without producing symptoms. This is well demonstrated in a case (fig. 1) in which a 30 year old man with a teratoma filling one half to two thirds of his left thoracic cage had no complaints. The presence of paralysis of the vocal cords or of Horner's syndrome is considered indicative of a malignant process. However, occasionally one is pleasantly surprised to find at exploration a benign tumor producing these changes. A 28 year old woman (fig. 2) had a large bronchogenic cyst which produced a change in voice and

a cough resembling the roar of a sea lion. Postoperatively her voice and cough returned to normal pitch.

The type and distribution of mediastinal tumors as found at surgical exploration are shown in the following table. We have also taken the liberty of including Blades's collective report from the five army thoracic centers. The two series total 145 cases of mediastinal tumors. The incidence of the various types of tumors is listed.

Although a rather large number of tumors was noted, each of the four subdivisions of the mediastinum was dominated by one or possibly

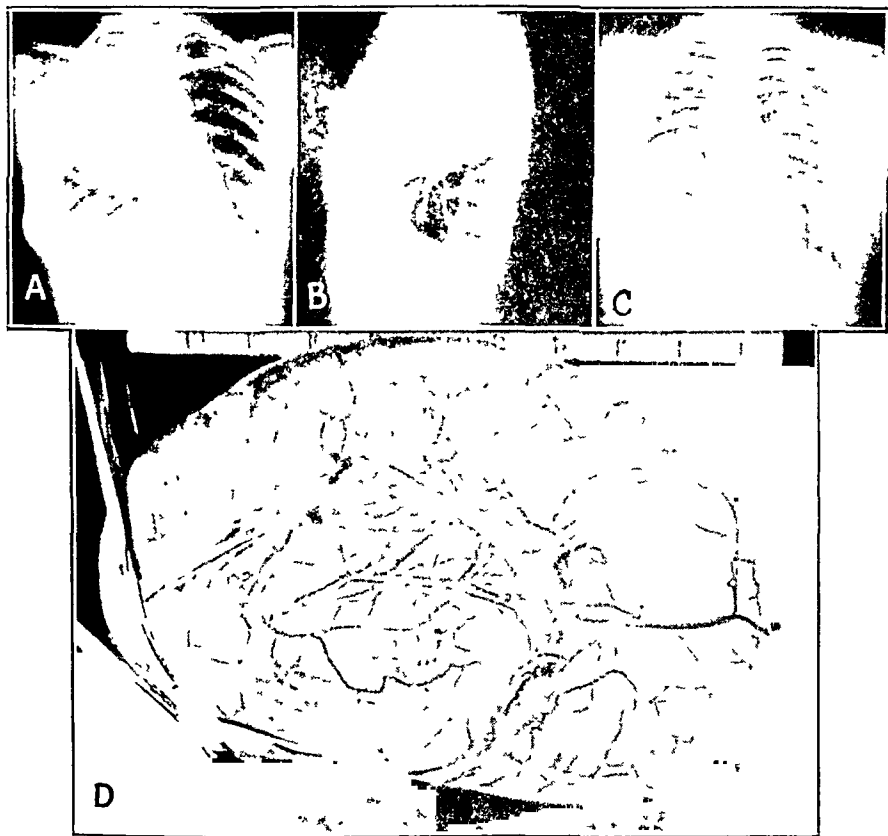


Fig. 2.—Benign bronchogenic cyst simulating malignant tumor because of vocal cord paralysis *A* and *B*, anteroposterior and lateral views demonstrating size and location of cyst. Right lung is compressed into lower one third of right pleural space *C*, six months postoperatively lung has expanded to fill entire thoracic cage. *D*, specimen removed.

two tumors. Thus, purely on the basis of position, fairly accurate prognostication can be made, because 75 per cent of the anterior mediastinal tumors are of dermoid derivation; 50 per cent of the mid-mediastinal tumors are bronchogenic cysts, and 92 per cent of the posterior mediastinal tumors originate from neurofibromas. Frequently these three tumors will extend to or occupy a superior mediastinal

position. Thyroid adenomas and thymomas will be found to constitute 65 per cent of the tumors occupying the anterior half of the superior mediastinum. A higher incidence of correct diagnosis can be made if close cooperation exists between clinician and roentgenologist. Invaluable aid in the differential diagnosis can be derived by utilizing the patient's age, clinical course, physical findings and response to clinical tests and therapy. For example, a single tuberculous gland may simulate a benign mediastinal tumor, but a history of protracted influenza,

Incidence of Mediastinal Tumors According to Location

	Our Series	Brian Blades's Collective Report of Five Army Thoracic Centers	Total
Anterior Mediastinum:			
Benign—dermoid and teratoma.....	11	14	25
Malignant teratoma.....	1	6*	7
Pericardial cyst.....	2	10	12
Midmediastinum:			
Bronchogenic cyst.....	2	23	25
Lipoma	1	3	4
Gastric cyst.....	1	0	1
Aneurysm	1	0	1
Benign lymphomas.....	1	5*	6
Malignant lymphomas.....	1	2*	3
Hodgkin's disease.....	1	4*	5
Posterior Mediastinum:			
Benign primary nerve tumor.....	6	29	35
Malignant primary nerve tumor.....	1	1*	2
Leiomyoma or esophageal cyst.....	1	1	2
Fibroma	0	1	1
Superior Mediastinum:			
Thyroid adenomas.....	3	2	5
Thymomas	1	4*	5
Malignant thymoma.....	1	2	3
Cystic hygroma.....	1	0	1
Tuberculomas	0	2	2
Total.....	36	109	145

* Extensive invasion of the tumor precluded even partial removal in all except 3 cases.

associated with loss of weight, intermittent fever, weakness and a positive reaction to the Mantoux test would not be in keeping with a benign tumor. In another instance a mediastinal tumor in a patient manifesting loss of weight, weakness, malaise and possibly peripheral lymph glands, would indicate malignant lymphoma or possibly a metastatic malignant growth in the mediastinum. An anterior-superior mediastinal tumor in a child would be consistent with thymic hyperplasia, whereas in an adult a thymoma or a thyroid adenoma would be the primary consideration.

In the diagnosis of mediastinal tumors, free rein should be given the roentgenologist to obtain those roentgenologic studies he considers



FIG. 3.—The bilateral mediastinal enlargement ordinarily found in lymphoma in contrast to unilateral enlargement in benign tumors.



FIG. 4.—Atypical unilateral Hodgkin's granuloma simulating benign tumor.

necessary and desirable. Fluoroscopy is advisable as a preliminary study, and after pneumothorax it may demonstrate tumor pulsation. Posteroanterior and lateral roentgenograms are mandatory to determine the size and location of the tumor. An oblique view occasionally is required to localize a lesion. Bronchograms outline the tracheobronchial tree



Fig. 5—Atypical unilateral small cell lymphosarcoma simulating a benign tumor. *A* and *B*, tumor in posterior mediastinum, *C*, photograph of resected specimen.

and show the relationship between it and the tumor. Pneumothorax is exceedingly valuable in determining whether the tumor arises from the lung, diaphragm, pericardium or mediastinum. Angiograms may be considered if an aneurysm is suspected and no pulsations of the tumor

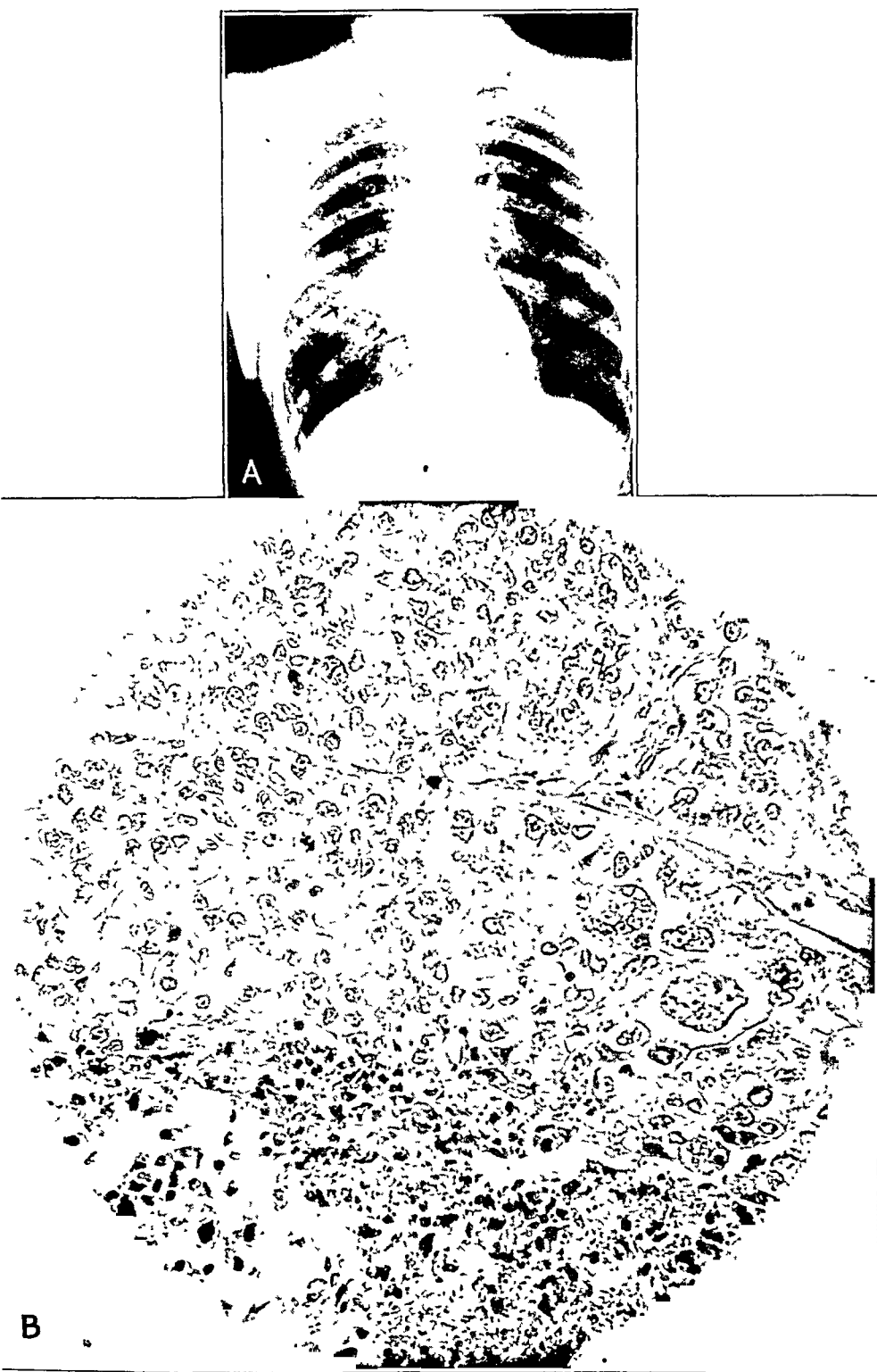


Fig. 6.—*A*, typical hazy, irregular outline of bronchogenic carcinoma (arrows); *B*, microscopic section.

are noted on fluoroscopy. Esophageal swallow of barium may demonstrate attachment or relationship of a tumor to the esophagus, trachea or bronchus.

In the establishment of a diagnosis of a resectable mediastinal tumor, malignant lymphomas and bronchogenic carcinoma are often difficult to exclude. Ordinarily, lymphomas appear as bilateral enlargements in the mediastinum with a sharp margin but irregular outline (fig. 3). In addition, glands may be palpated peripherally, and the clinical course is progressively downhill. Occasionally, atypical lymphomas appear as enlargement of a solitary gland without peripheral evidence of nodal enlargement. These cannot be definitely differentiated from benign mediastinal tumors. There were 2 such tumors in our series, one a Hodgkin's granuloma and the other a small cell lymphosarcoma (figs. 4 and 5). Both lesions were resected. The patient with

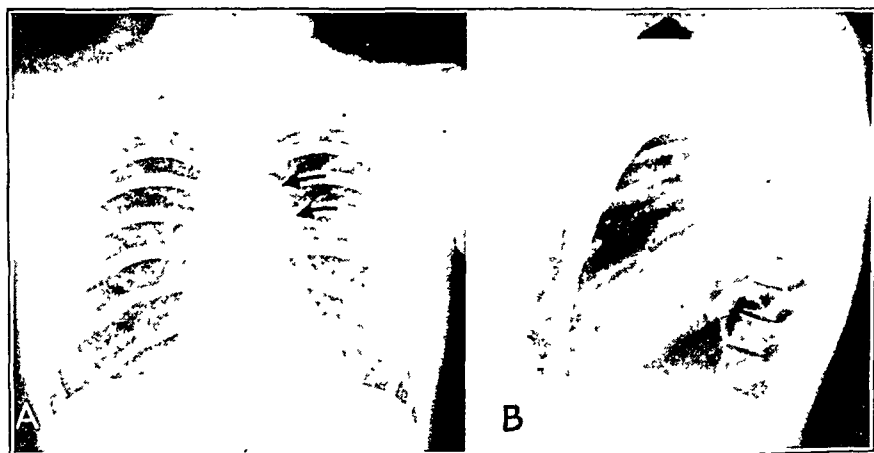


Fig. 7.—Small dermoid situated in upper anterior mediastinum (arrows).

Hodgkin's disease died a year and four months after operation from a coronary occlusion. Postmortem examination showed no evidence of Hodgkin's disease anywhere in the body. In the second case there was no evidence of recurrence one year postoperatively. The findings and results in these rare and unusual cases of unilateral malignant lymphomas are in line with those reported by Evans and Haight³ and Bradford, Mahon and Grow.⁴ Whether or not a cure has been effected in these cases only time can tell.

Bronchogenic carcinoma situated at the hilus usually presents no problem since the lesion, by occluding the bronchus, produces atelectasis.

3. Evans, B. H., and Haight, C.: Surgical Removal of Unsuspected Mediastinal Lymphoblastomas, *Arch. Surg.*, to be published.

4. Bradford, M. L.; Mahon, H. W., and Grow, J. B.: Mediastinal Cysts and Tumors, *Surg., Gynec. & Obst.* **85**:467 (Oct.) 1947.

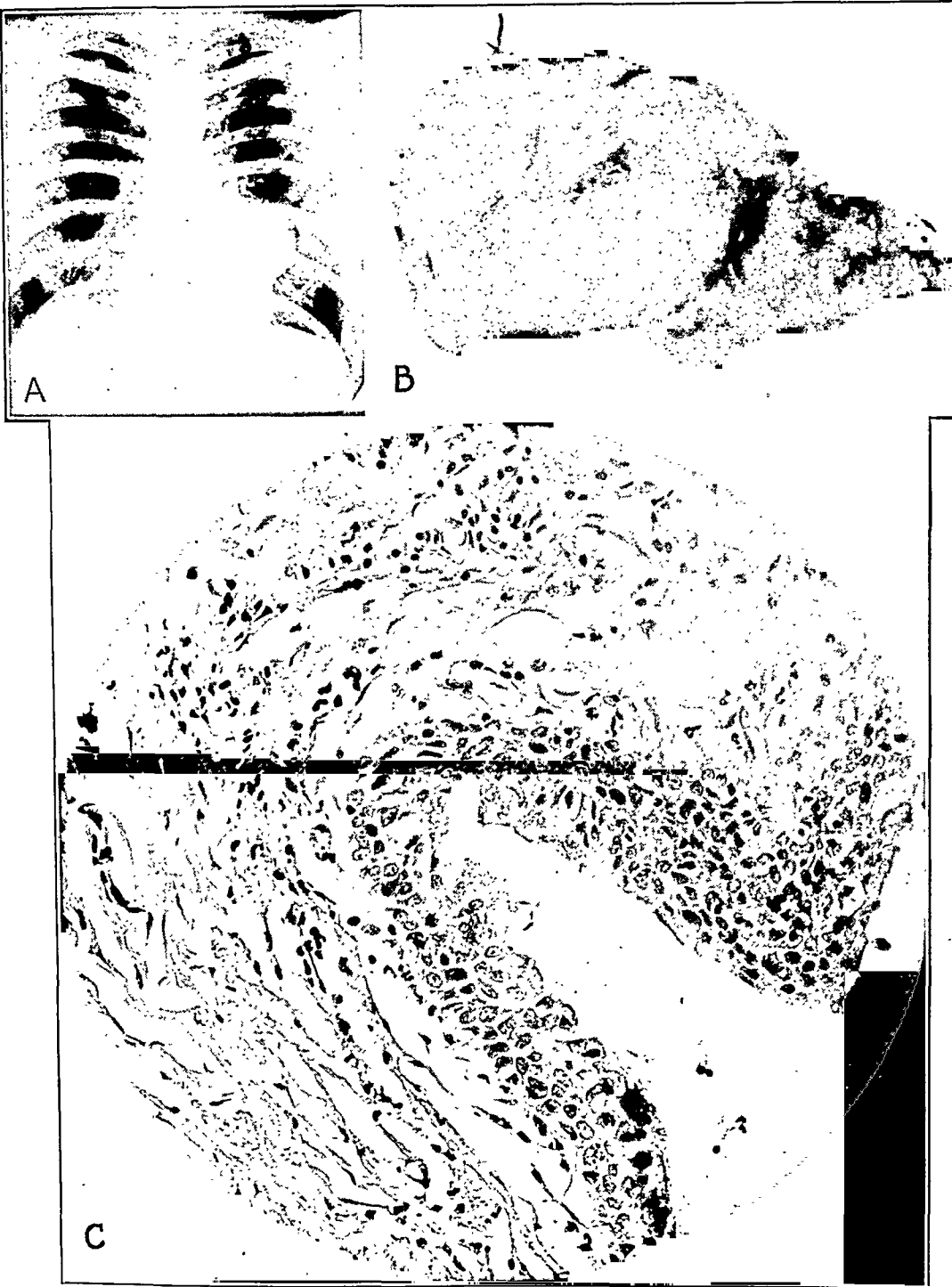


Fig. 8.—*A*, moderate dermoid situated in lower anterior mediastinum. *B*, resected specimen. Note hair protruding from a tiny opening in dermoid cyst. *C*, photomicrograph showing epidermal and mesodermal tissue.

In certain instances there is peribronchial spread and growth of the lesion toward the hilus. The dense carcinoma without atelectasis may simulate a mediastinal tumor. However, on examination of the border



Fig. 9.—*A* and *B*, larger anterior teratoma than the one in figure 8. *C*, three months postoperatively, with lung completely expanded. *D*, resected tumor opened, containing bone and pathognomonic cholesterol crystals, shown in glass dish.

of such a bronchogenic carcinoma, a hazy and irregular outline will be observed (fig. 6).

Primary tumors of the mediastinum, other than those of lymph node origin, appear as a single lesion, round or ovoid in shape, with

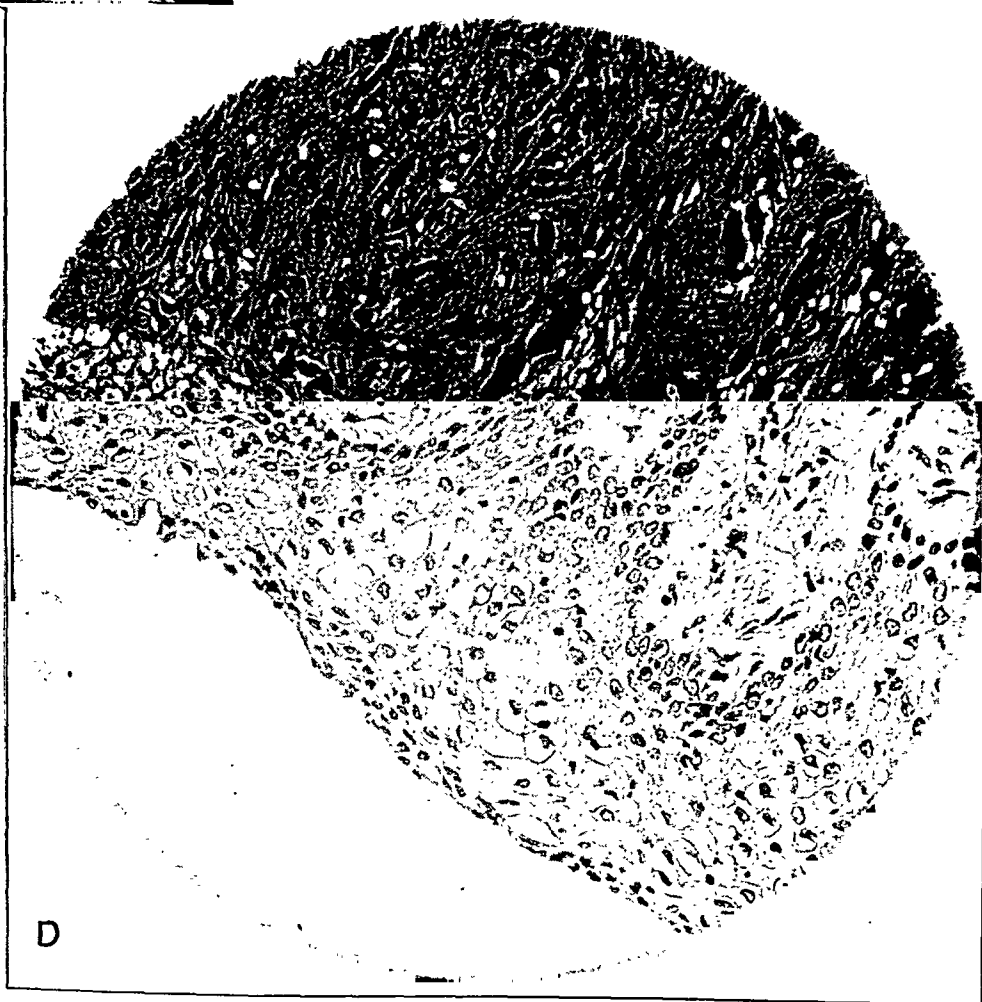
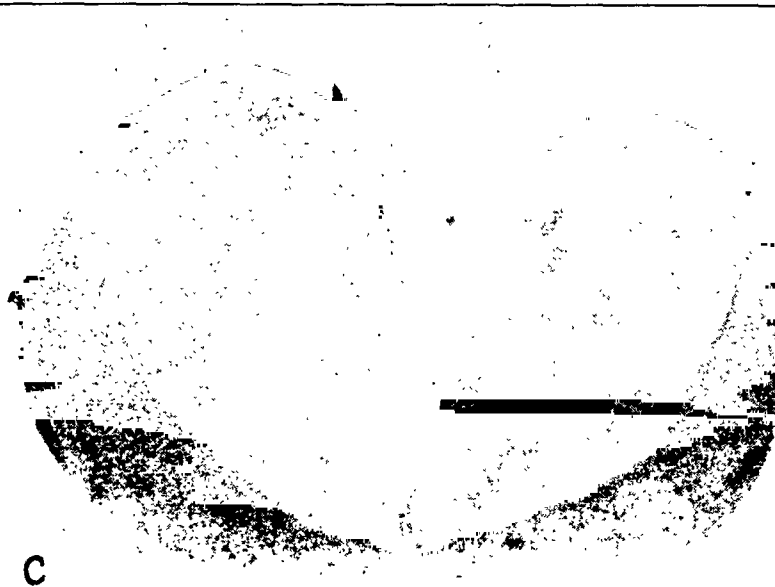
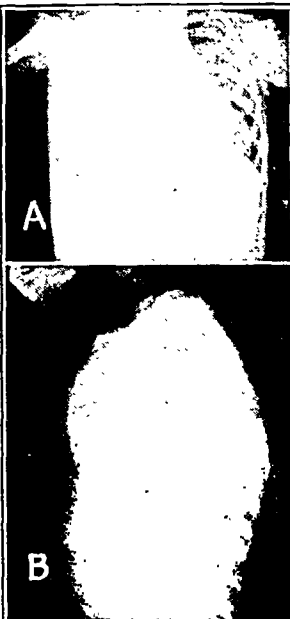


Fig. 10.—*A* and *B*, enormous dermoid in a child filling more than one half of the right thoracic cage; *C*, resected specimen opened. *D*, photomicrograph revealing typical dermoid architecture.

a sharp and distinct outline. In the anterior mediastinum the dermoid group and pericardial cysts predominate. The dermoids are found anywhere in the anterior mediastinum, and their density may vary from homogeneous to one of calcification, bone and teeth formation. The presence of bone and/or teeth is highly suggestive of teratoma (figs. 7, 8 and 9). At times dermoids may become so large as to fill practically one half of the thoracic cage (fig. 10). In such cases the exact type of tumor may be difficult to state, although one should bear in mind that dermoids and neurofibromas are the most common types of large mediastinal tumors.

In 2 cases unusual pictures were presented because the physician failed to take proper roentgenograms. In both instances only a postero-



Fig. 11.—*A*, anteroposterior view. Dermoid situated anteriorly but cannot be appreciated from this view only. Child was aspirated posteriorly, with drainage of dermoid contents into general pleural space. *B*, anteroposterior view after cyst aspirated. Yellow thick fluid obtained, containing no organisms, but cholesterol crystals present. Note cholesterol above fluid level of cyst. Also the dermoid secretion in general pleural cavity can be recognized.

anterior film was taken, a diagnosis of a localized empyema made and the chest aspirated posteriorly. This aspiration produced a drainage of the dermoid cystic material into the general pleural space, and a dermoid pleural effusion resulted. At the time of the patient's admission to the Wisconsin General Hospital (fig. 11), anterior aspiration revealed sterile effusion containing cholesterol crystals—a pathognomonic sign of a dermoid. On cut section a dermoid presents a varied picture, from cystlike fluid to one containing hair, sebaceous material, bone or teeth. In rarer instances teratomas undergo malignant degeneration.

Pericardial cysts may simulate dermoids. They are along the cardiac border, usually on the left side. On fluoroscopy they transmit the cardiac pulsations, and pneumothorax definitely clinches the diagnosis since they are attached to the pericardium (fig. 12).

In the midmediastinum a variety of lesions may be seen. Oddly enough there were but two bronchial cysts in our series, whereas the collective report of Blades had twenty-three in a total of 109 cases.

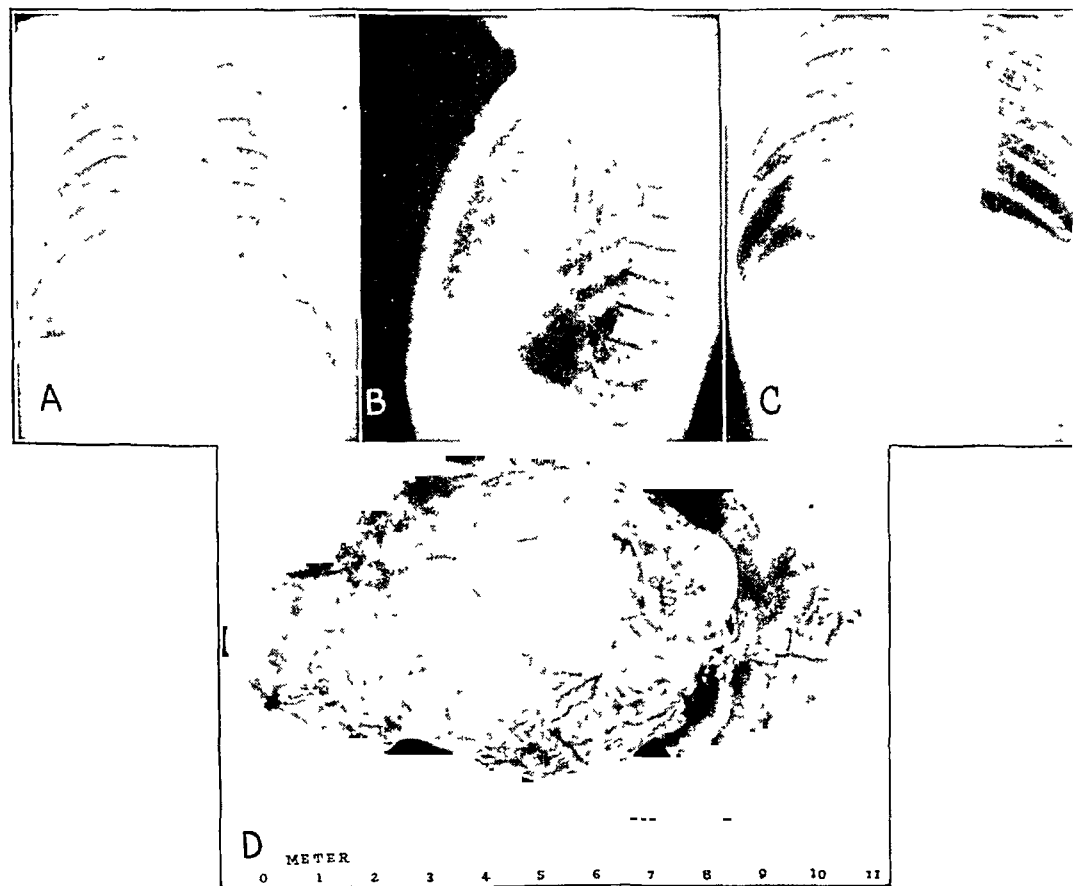


Fig. 12.—Pericardial cyst. *A* and *B*, anteroposterior and lateral views showing anterior mediastinal tumor. *C*, after pneumothorax. Tumor appears attached to pericardium. On fluoroscopy tumor transmits cardiac pulsation. *D*, resected specimen.

These tumors originate in the midmediastinum but may extend in any direction, and in some instances they attain a large size. They are single homogeneous masses of fluid density with a sharp outline. When cut, our specimens contained thin, clear fluid (fig. 13). Another cyst, simulating a bronchial one, turned out on microscopic section to be a gastric cyst (fig. 14). The microscopic section showed atypical gastric mucosa. An interesting tumor was observed near the ascending aorta,

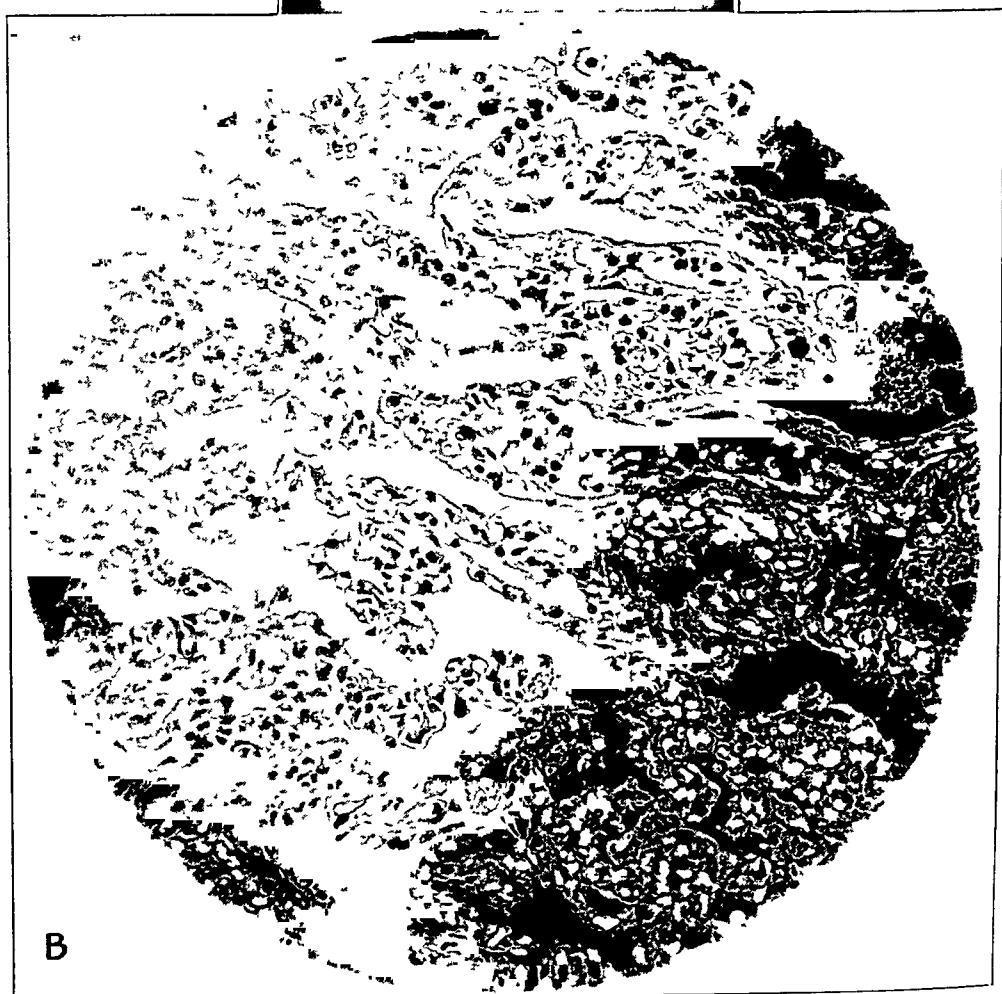
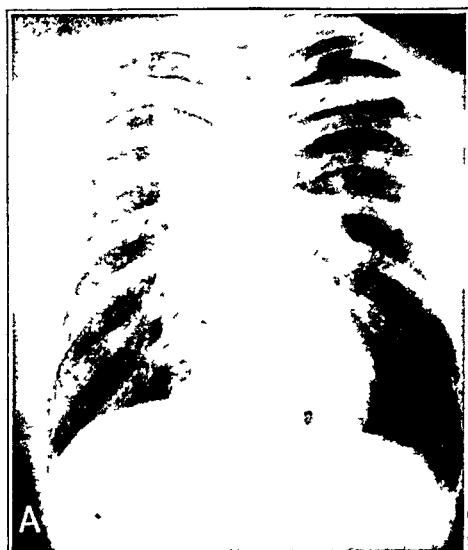


Fig. 13—Bronchial cyst, situated in midmediastinum.

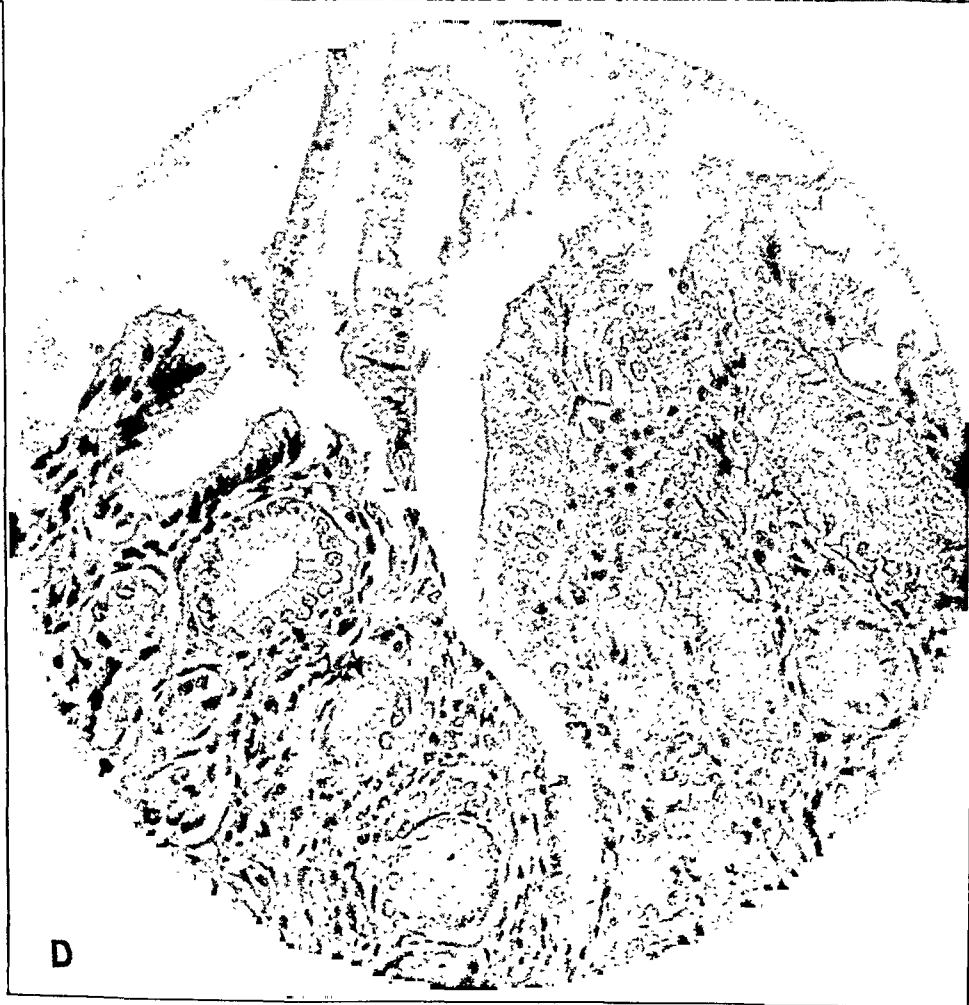
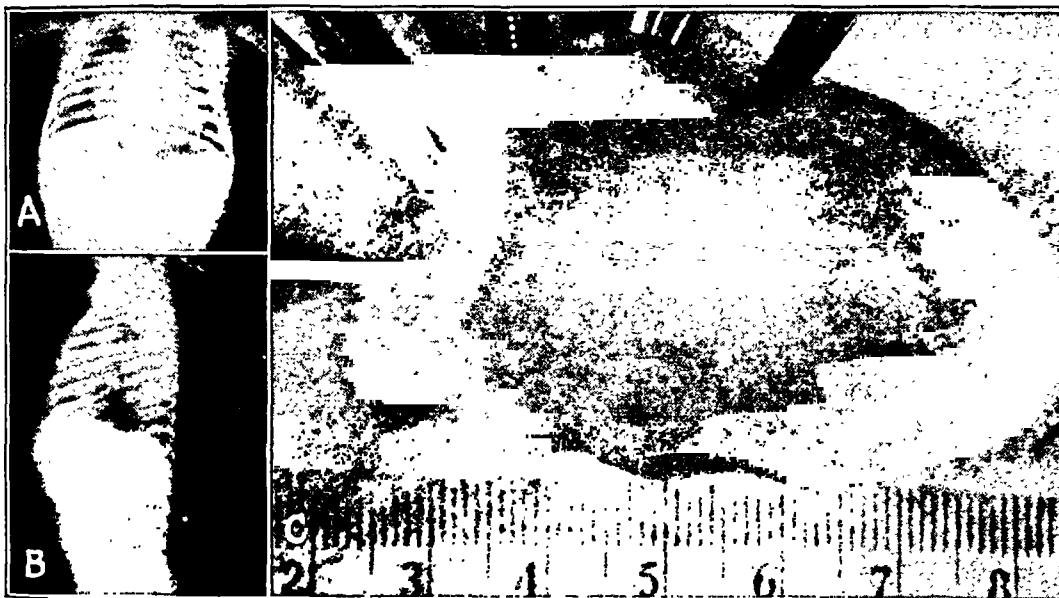


Fig. 14.—*A* and *B*, gastric cyst, showing tumor arising in midmediastinum but occupying a more posterior position; *C*, resected specimen; *D*, photomicrograph showing typical gastric mucosa.



Fig. 15.—Aneurysm which after pneumothorax and fluoroscopy showed no pulsation. Note its origin from ascending aorta.

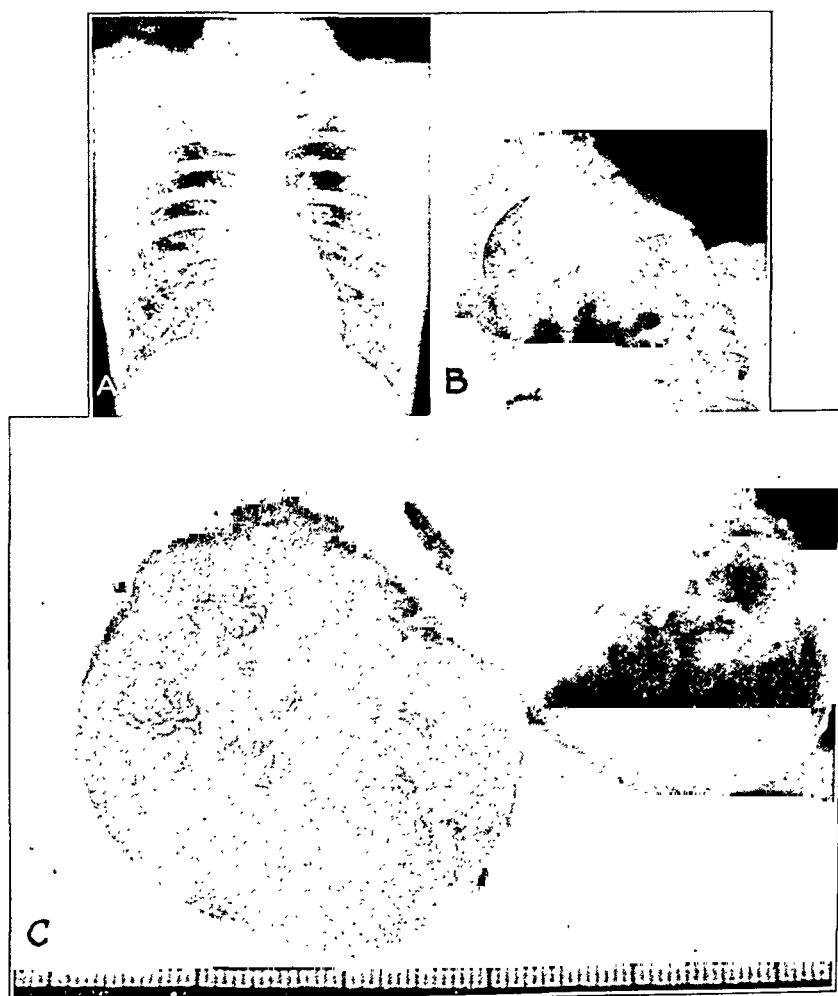


Fig. 16.—*A* and *B*, posterior mediastinal tumor shown in anteroposterior and oblique views; neurofibroma. Tumors are frequently of dumbbell shape. Note sharp outline. *C*, resected dumbbell-shaped tumor.

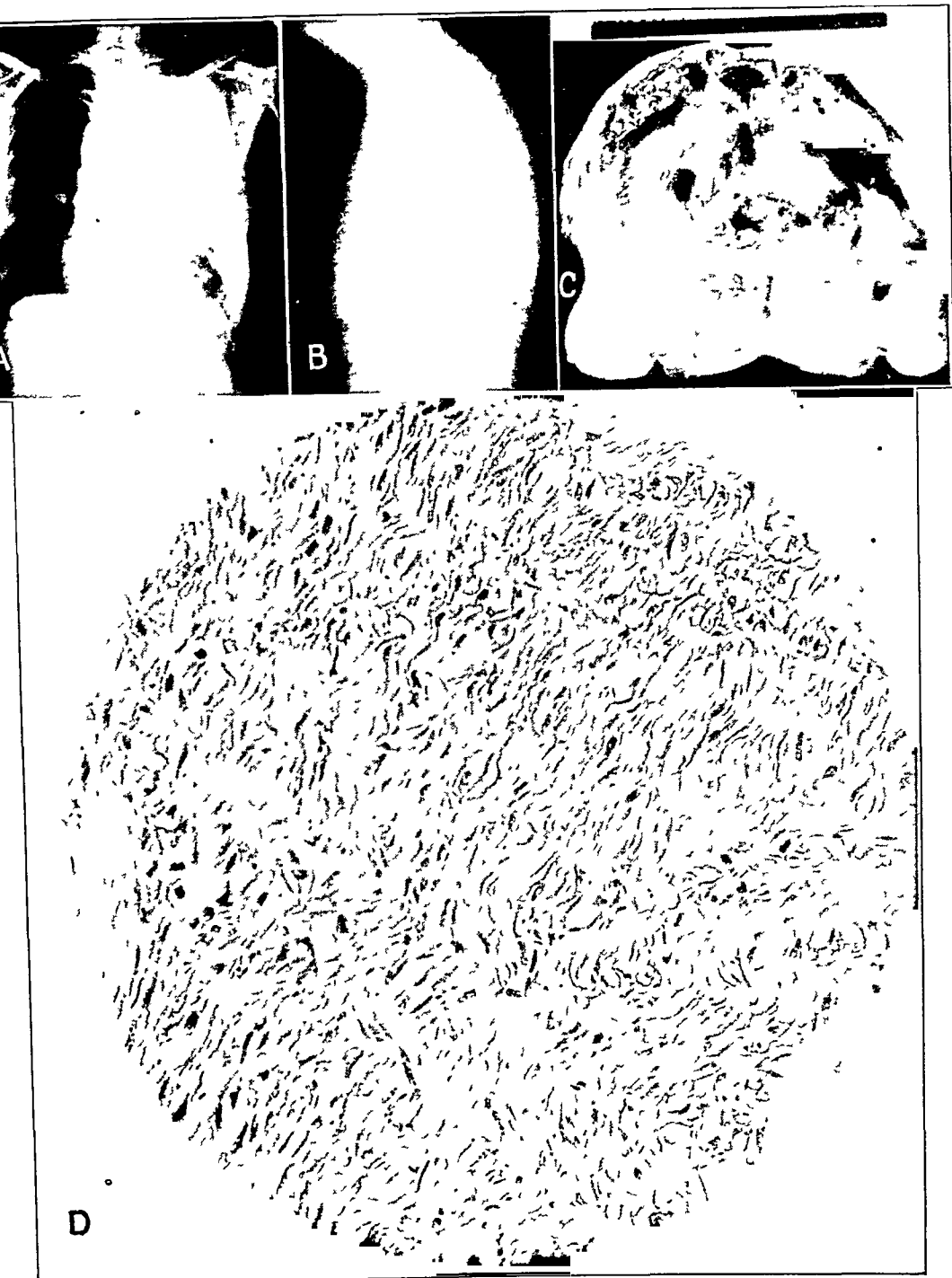


Fig 17.—*A* and *B*, anteroposterior and lateral views reveal tremendous mediastinal tumor. In lateral view relation of tumor to bronchial tree can be visualized by iodized oil. *C*, resected tumor—cut section, showing cystic changes from degeneration. *D*, photomicrograph is typical of benign neurofibroma.

and after pneumothorax and fluoroscopy no pulsation was noted. Even at the time of surgical intervention this aneurysm of the ascending aorta showed no pulsation (fig. 15). This tumor is remarkable not only because of its failure to transmit a pulse wave but also because aneurysms of the ascending aorta are rare.

Posterior mediastinal tumors should be considered as arising from nerve tissue until proved otherwise. An extreme posterior mediastinal position and soft tissue density with sharp outline are classic (fig. 16). These tumors may also grow into the spinal canal, producing a dumb-bell type of tumor which may erode a portion of the vertebrae. At

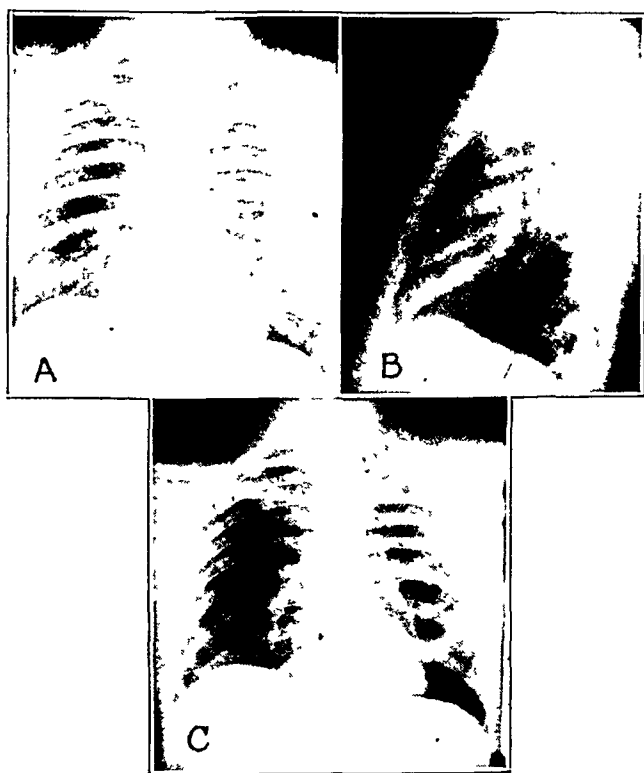


Fig. 18.—*A* and *B*, malignant neurofibroma. The patient had symptoms of expanding intracranial tumor; there were also café au lait spots and a posterior mediastinal tumor. Resection of the thoracic tumor showed malignant neurofibroma, with the cranial lesion a result of metastasis. *C*, postoperative roentgenogram.

times they may attain huge size and undergo cystic changes (fig. 17). Like teratomas, in rare instances they also undergo malignant degeneration. One of our patients was admitted with symptoms of an expanding intracranial lesion. In the course of study, typical café au lait spots were found as well as a posterior mediastinal tumor (fig. 18). The diagnosis of a possible neurosarcoma was made, and on thoracic exploration this impression was verified. In this area leiomyoma (fig. 19) or esophageal cysts are found on rare occasions.

Thyroid adenomas and thymomas are the most frequent tumors found in the superior mediastinum. Thyroid adenomas are usually seen slightly to one side of the mediastinum, appearing round with a



Fig. 19.—*A* and *B*, leiomyoma of esophagus. The esophagram demonstrated deviation of barium flow. *C*, resected tumor.

sharp outline, and their density may vary from soft tissue to one of calcification. On fluoroscopy they will be seen to move with swallowing (fig. 20). Recently we employed radioactive iodine to rule out

mediastinal thyroid in a case demonstrating a round tumor which moved on deglutition (fig. 21). However, the Geiger counter showed this tumor failing to take up iodine, and it was therefore assumed to be nonthyroid in origin. Exploration showed it to be carcinoma metastatic from the lung.

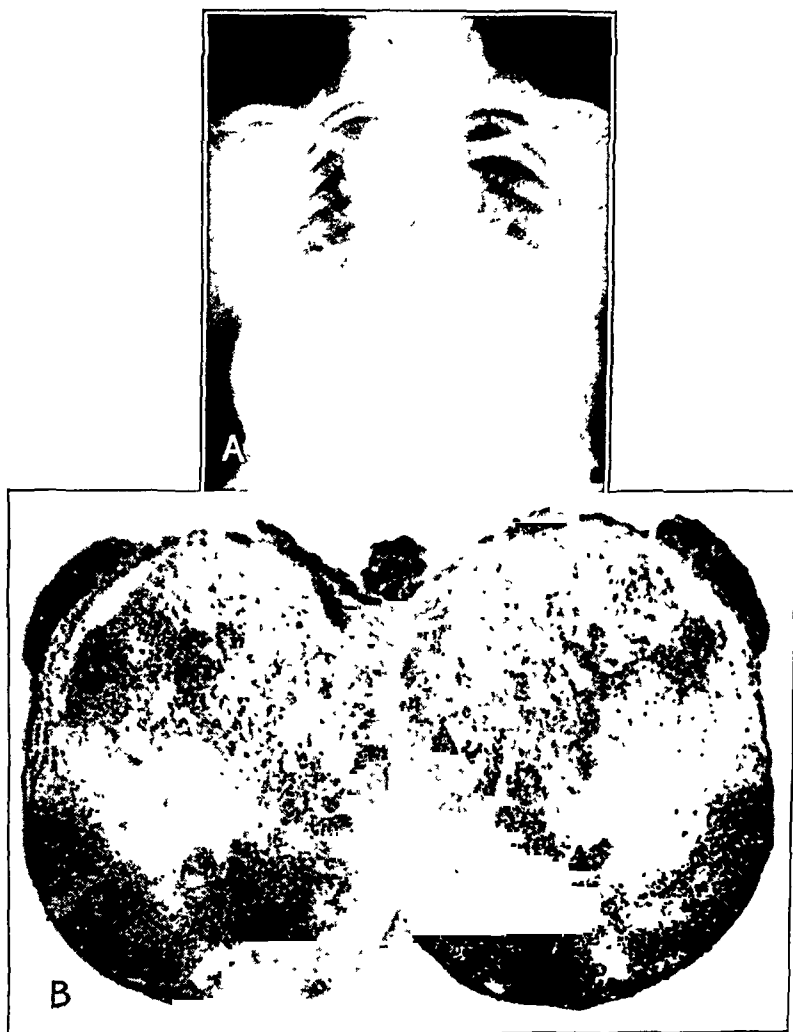


Fig. 20.—Superior mediastinal thyroid adenoma. *A*, superior mediastinal tumor. Fluoroscopy showed tumor to move on swallowing. *B*, cut section of thyroid adenoma.

Thymic tumors in the adult can be recognized by their anterior position in the superior mediastinum and their quadrilateral appearance. In our only case of thymoma the typical picture was not seen. Cystic hygromas are found in infants, and in practically all instances extension into the neck can be seen.

The therapy for mediastinal tumors consists of the judicious use of surgical treatment and irradiation. Since benign mediastinal tumors do not respond to irradiation we have taken the stand at the Wisconsin General Hospital that all unilateral mediastinal tumors should be explored. Occasionally one may remove a unilateral malignant lymphoma or a benign mediastinal tumor which has undergone malignant degeneration. In either event, exploration with resection of a portion of or the entire primary tumor offers the patient a better prognosis, because in a small percentage a cure may result or on the basis of the biopsy more specific irradiation may be offered to the patient. One must keep in mind that thoracic exploration and resection of benign tumors is a relatively simple procedure. On the other hand, when these tumors attain huge proportions, produce complications or undergo malignant



Fig. 21.—Tumor simulating possible intrathoracic tumor. Fluoroscopy showed it to move on deglutition. Radioactive iodine was administered, but the Geiger counter showed no uptake of iodine. Diagnosis of malignant tumor was then made and verified by thoracotomy and biopsy.

degeneration, surgical intervention becomes more hazardous. For malignant lymphomas with bilateral mediastinal distribution the treatment of choice at present is irradiation therapy. As in the reports of Blades and of Bradford, Mahon and Grow, there were no deaths in our series attributable to resection of a mediastinal tumor.

DISCUSSION

DR. S. W. HARRINGTON, Rochester, Minn.: I wish to compliment Dr. Curreri on his excellent presentation of the series of mediastinal tumors which he is reporting for Dr. Gale and himself. Mediastinal tumors are now being recognized more frequently because routine roentgenograms are being taken by mobile units on mass groups of patients who do not have subjective symptoms. These studies have revealed many indeterminate lesions, and it is important that complete

roentgenologic and physical examinations be made on these patients to determine the type of lesion. If the findings indicate an intrathoracic tumor, surgical treatment should be considered regardless of whether or not the tumors are producing symptoms because they are potentially malignant and may undergo malignant change.

I have recently reported a series of 168 cases of intrathoracic extrapulmonary tumors which I have removed since 1925. The incidence of tumors in the different intrathoracic regions is essentially the same as that reported by Dr. Curreri, although the percentage of malignant lesions is a little higher. Of this series, approximately 20 per cent were malignant growths.

The most common tumors in the anterior mediastinum of my series were teratomas and thymomas. There were 40 teratomas, of which 15 per cent had undergone malignant change. As Dr. Curreri has pointed out, the most common tumors located in the posterior mediastinum are primary nerve tumors. In my series there were 51, of which 5 per cent had undergone malignant change.

I should also like to point out that nerve paralysis is usually caused by malignant growths, but it can occur from benign lesions when the tumor involves the recurrent laryngeal nerve. I have seen cord paralysis produced by a benign neurofibroma and also Horner's eye syndrome produced by a benign ganglioneuroma.

I thoroughly agree with Dr. Curreri and Dr. Gale in that all intrathoracic growths should be thoroughly investigated and should be removed surgically unless operation is contraindicated, as all these growths are potentially malignant.

DR. A. R. CURRERI, Madison, Wis.: I should like to thank Dr. Harrington for his discussion. It should be pointed out that he is one of the pioneers in mediastinal surgery, and his enthusiasm and results were responsible for the undertaking of this type of surgery by us.

SUPPURATIVE DISEASE OF THE LUNGS

FRED R. HARPER, M.D.
WILLIAM B. CONDON, M.D.
AND
WILLIAM H. WIERMAN, M.D.
DENVER

SUPPURATIVE disease of the lungs, which includes bronchiectasis, pulmonary abscess and infected pulmonary cysts, has always been a serious and confusing problem. A great deal has been written on this subject, and many forms of treatment have been recommended in order to reduce the high morbidity and mortality in this group of pulmonary lesions. It is only in the last five or six years that rapid advances in treatment, both medical and surgical, have reduced these conditions to the status of infections in other parts of the body. At the present time the diagnosis is relatively accurate, the treatment is specific and surgical intervention is safe. We feel that in the light of the present knowledge of these conditions, it might be well to reevaluate the accumulated information on the subject. We are also adding our own experience to show that when patients with these diseases are properly handled, their condition can be treated as successfully as suppurations elsewhere in the body.

The patients we are reporting on include only those on whom we have operated during the last two and one-half years since we returned from military service. During that period, we have had all the advanced methods of treatment available to us.

PATHOGENESIS OF SUPPURATIVE DISEASE OF THE LUNGS

Our conception of bronchiectasis is based on the experimental work of Tannenberg and Pinner.¹ In that important study, using rabbits, several fundamental principles were brought out.

1. By completely obstructing a normal bronchus, true atelectasis could be produced, but this uncomplicated atelectasis did not lead to bronchiectasis or suppuration of the lungs.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 3, 1948.

1. Tannenberg, J., and Pinner, M.: Atelectasis and Bronchiectasis, *J. Thoracic Surg.* **11**:571-616 (Aug.) 1942.

2. If partial obstruction was produced, in the presence of infection pneumonitis resulted which rapidly led to extensive saccular bronchiectasis in about four weeks.

3. Contralateral bronchopneumonia which developed in some of the rabbits with bronchiectasis did not develop into bronchiectasis in the absence of obstruction.

4. In some of the rabbits in which pneumonitis and early bronchiectasis from the presence of obstruction plus infection had developed,



Fig. 1.—Atelectasis not complicated by infection.

the obstruction was dislodged between the seventh and tenth days. In these rabbits the lung became normal again within thirty to sixty days.

If these important experimental findings are applied to clinical bronchiectasis in human beings, some basic principles can be deduced.

1. True uncomplicated atelectasis rarely exists in human beings because sudden complete obstruction of a normal bronchus leading to a normal lung does not take place.

2. The pathogenesis of bronchiectasis in human beings is partial obstruction plus infection which causes pneumonitis (rather than atelectasis) and results in bronchiectasis.

3. Bronchiectasis can develop rapidly in about four weeks, if obstruction plus infection is present.

4. Vigorous treatment during the first and second weeks directed at removal of the obstruction and reduction of infection will result in complete healing without permanent changes in the lung.

These principles are illustrated in the following 2 cases:

The first one is an example of true uncomplicated atelectasis (fig. 1). The patient was a soldier who was shot through the chest, with resulting total collapse of the left lung. The soldier was seen by one of us three weeks after the injury. At that time he had a total pneumothorax, with high negative intrapleural pressure but no fever.

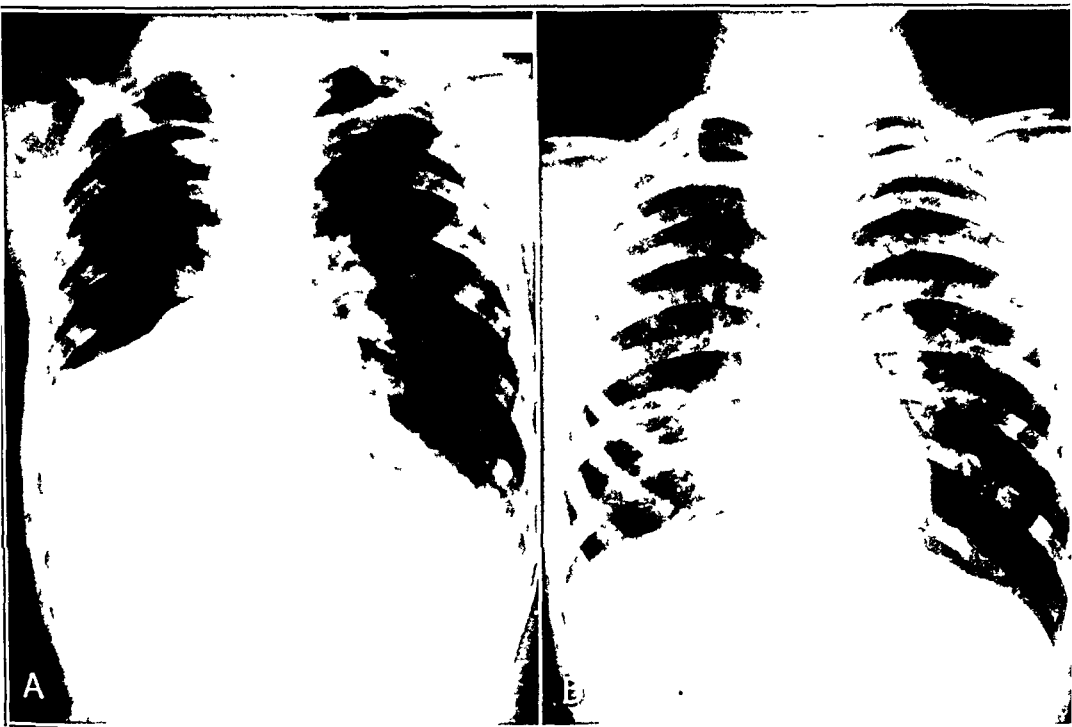


Fig. 2—*A*, pneumonitis of middle and lower lobes of right lung following respiratory infection. *B*, reexpanded middle and lower lobes after removal of obstruction with bronchoscopy. There was no permanent damage to the lung.

leukocytosis or pleural fluid. Bronchoscopic examination was carried out, and as soon as the left bronchus was approached, a membrane was seen. Clear fluid poured out of the bronchoscope as soon as the membrane was perforated. The bronchial mucous membrane appeared normal. The next day the lung started to expand, and within four days it was completely expanded. Subsequent bronchograms showed no evidence of bronchiectasis. This unusual case is an example of total obstruction of a normal bronchus with true atelectasis but without infection. The result bore out the findings in experimental animals in that the lung expanded completely and was not damaged.

The second case illustrates the result of early treatment of pneumonitis by the establishment of free bronchial drainage. The patient was an 11 year old boy who had a respiratory infection with a persistent cough. Roentgenograms showed airless middle and lower lobes on the right side (fig. 2A). After one bronchoscopy the lower lobe expanded, and after a second one the middle lobe expanded and became aerated (fig. 2B). This child had no residual bronchiectasis because the condition was recognized early enough to establish bronchial drainage before irreversible changes had taken place.

TABLE 1.—*Origin of Bronchiectasis and Pulmonary Abscess*

Bronchiectasis	
Pneumonia or children's diseases.....	25
Tuberculous bronchial stenosis.....	12
Adenoma of bronchus.....	4
Foreign body.....	2
Broncholiths	1
Unknown cause.....	1
Pulmonary Abscess	
Pneumonia or pneumonitis.....	7
Postoperative complication.....	6
Dental extractions.....	4
Foreign body.....	3
Tumor	2
Chest injury.....	2
Broncholiths.....	1
Swimming.....	1
Unknown cause.....	1
Total.....	72

RELATIONSHIP OF BRONCHIECTASIS TO PULMONARY ABSCESS

The principles underlying the development of bronchiectasis would seem to us to apply in most cases of pulmonary abscess. We agree with Samson that pulmonary abscess in general is a disease of aspiration rather than an embolic disease. In pulmonary abscess the infection is peripheral in location and the smaller bronchi are obstructed so that adequate drainage through the bronchus is difficult to obtain. However, in most cases of pulmonary abscess, as in bronchiectasis, the two main factors of obstruction and infection are present. The similar pathogenesis of the two conditions is evidenced by the fact that in our series there were many cases of bronchiectasis in which the cause was the same as that in other cases of pulmonary abscess (tables 1 and 2). For example, either bronchiectasis or pulmonary abscess resulted from pneumonia or pneumonitis, foreign body aspiration, tumors or broncholiths.

In many of our cases it was difficult to decide whether the suppurative disease of the lungs should be classified as bronchiectasis or pulmonary abscess. In neglected cases of bronchiectasis pulmonary abscess and even putrid empyema will often develop. Conversely, improperly drained pulmonary abscess will result in residual secondary cavities and bronchiectasis of varying degree and extent.² Therefore, it would seem logical to consider bronchiectasis and pulmonary abscess together under the heading of suppurative disease of the lungs.

TREATMENT

The treatment of suppurative disease of the lungs can be divided into four phases: (1) prevention, (2) combating the infection, (3) establishing drainage and (4) removal of irreversibly damaged pulmonary tissue.

Prevention.—Prevention serves its best use in careful attention to details in managing the conditions which may lead to suppurative dis-

TABLE 2.—Types of Suppurative Disease

Bronchiectasis.....	45
Pulmonary abscess.....	27
Infected pulmonary cyst.....	2
Total.....	74

ease of the lungs. For example, a child with whooping cough or measles should be carefully watched for evidence of complicating pneumonitis which may lead to bronchiectasis. The patient who is to undergo a surgical operation should be carefully examined for evidence of poor dental hygiene. Smith³ has shown that the organisms which cause pulmonary abscess are found in abundance around infected teeth. After operation, the patient should be watched for indications of postoperative atelectasis or, more properly, obstructive pneumonitis. If this post-operative complication is corrected early, no damage to the lung will result. Foreign bodies in the bronchi should be recognized and removed at once.

Combating the Infection.—Since the introduction of antibiotics, the infection associated with the bronchial obstruction can be effectively combated. However, this treatment should be given early, vigorously and accurately. Smith³ has described the organisms most commonly found in the type of pneumonitis which leads to suppurative disease

2. Kent, E. M., and Ashburn, F. S.: Pulmonary Resection for Chronic Lung Abscess, *J. Thoracic Surg.* **17**:523-529 (Aug.) 1948.

3. Smith, D. T.: Medical Treatment of Acute and Chronic Pulmonary Abscesses, *J. Thoracic Surg.* **17**:72-90 (Feb.) 1948.

of the lungs and has recommended the drugs which are most effective. He feels that the majority of pulmonary abscesses result from the aspiration of infected material from the patient's own mouth or upper respiratory tract. These aspiration abscesses he divides into pyogenic and fusospirochetal types. The fusospirochetal type of infection results most frequently in a single isolated peripheral abscess, while the pyogenic organisms more often bring about multiple small abscesses (fig. 3). The sulfonamide drugs are effective in the pyogenic type



Fig 3.—Multiple pyogenic abscess requiring pneumonectomy.

and, combined with penicillin, afford excellent treatment. In the fusospirochetal infections, penicillin should be used intensively and early, with or without supplementary arsenicals, sulfonamide drugs or streptomycin. Smith³ has emphasized the importance of bacteriologic examination of the sputum so that the antibiotics may be administered specifically and accurately in order to obtain the best results.

Establishing Drainage.—As we mentioned before, obstruction to free drainage of the bronchi always accompanies the infection. Therefore, the other phase of treatment is to establish free drainage. The obstruction may follow as the result of infection, or the obstruction may precede the

infection, but it is always present and must be dealt with. Since the experimental work of Tannenberg and Pinner has given a rational basis for the time necessary to cause irreversible changes, one can judge how urgent it is to establish free drainage within one to two weeks. Therefore, suppurative disease of the lungs must be treated vigorously during the early stages.

Along with Samson,⁴ we are of the opinion that the question of the type of organism or the question of bronchoscopy versus open drainage or the question of whether the problem is medical or surgical is all more or less beside the point when it comes to establishing drainage. It is true that pyogenic abscesses are more liable to be multiple and less amenable to open drainage while fusospirochetal or putrid infections

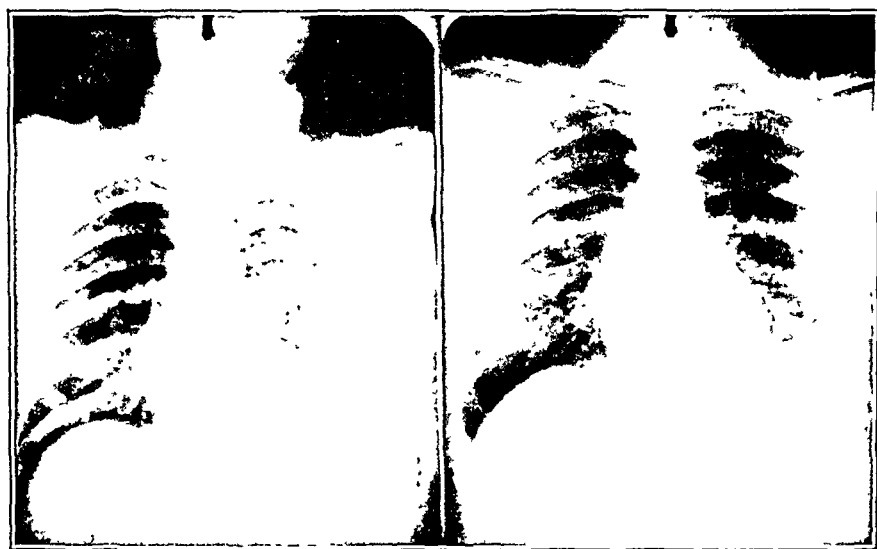


Fig. 4.—Pulmonary abscess cured with antibiotic therapy and bronchoscopy.

are more liable to be single and accessible to open drainage. However, the infection is rarely a pure type. The point is that free drainage must be established and established early. If this drainage can be established through the bronchus by the use of antibiotics and the position which will allow the best drainage, so much the better. In some cases one or more bronchoscopic treatments will establish drainage through the bronchus and result in resolution of the disease. However, time is important, and if these treatments, in the case of pulmonary abscess, are not producing clinical and roentgenologic results, they should be abandoned and drainage established externally. Specifically, a roentgenogram should be taken once a week and the first one that does not show marked and definite improvement should be evidence that the treatment

4. Samson, P. C.: Lung Abscess, *Dis. of Chest* **14**:79-91 (Jan) 1948.

is inadequate. Improvement in the roentgenograms should be confirmed by clinical improvement.

A case to illustrate this treatment is one in which the patient had a large abscess, as shown in the first roentgenogram (fig. 4). He was given adequate antibiotic therapy early. After one bronchoscopy, there was free drainage through the bronchus. Subsequent weekly roentgenograms showed progressive improvement, and he improved clinically. The second roentgenogram showed that complete resolution took place without surgical intervention.

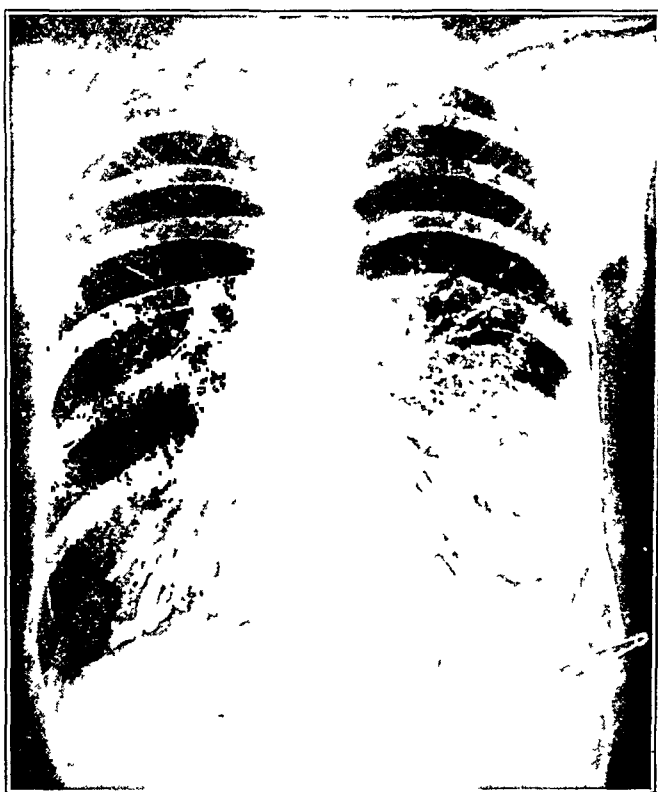


Fig 5—Bronchiectasis followed by pulmonary abscess and putrid empyema.

A large percentage of cases of pulmonary abscess will not respond to the treatment described. In these cases there must be adequate drainage before permanent changes, such as multiple abscess, fibrosis and bronchiectasis, occur. External drainage should be done. In other cases it is obvious that permanent changes have occurred, but the patient is too ill to warrant resection of the lung. When this occurs, external drainage should be carried out with the full knowledge that further surgical treatment will be necessary just as appendical abscesses are drained with the knowledge that subsequent appendectomy will be required. In still other cases the abscess will have been neglected until

it ruptures into the pleura, causing a putrid empyema (fig. 5). In these cases the empyema should be drained, with wide open drainage as a surgical emergency. Definitive surgical treatment can be carried out later.⁵

Removal of Irreversibly Damaged Pulmonary Tissue.—After a pulmonary abscess has advanced to the point where permanent changes such as multiple loculations, bronchiectasis and fibrosis have occurred, external drainage will at best be palliative. In such instances, if the condition of the patient warrants it, the diseased lung should be removed. In some cases, after external drainage the patient will not be completely well because undrained pockets and bronchiectatic areas remain. In these cases further attempts at drainage will not be successful; therefore removal of the involved lung is the only method of affecting a cure. In cases in which the obstruction cannot be relieved, as in the case of tumor, unremovable foreign body or tuberculous stenosis, the diseased lung including the obstructing lesion should be removed.

To these indications for resection should be added severe hemorrhage because external drainage will not relieve hemorrhage and may aggravate it. Some abscesses are not accessible for external drainage because of their location and should be resected. Children tolerate resection of the lung well and open drainage poorly. Resection, therefore, is to be preferred in the treatment of children. Glover and Clagett,⁶ in listing eight indications for pulmonary resection in cases of abscess of the lung, include abscesses in children.

In instances of bronchiectasis the lesions are irreversible when the diagnosis is established. Therefore, removal of involved pulmonary tissue is the only method of curing the disease. It is important that accurate diagnosis of the extent of the disease be made so that the amount of tissue to be removed can be estimated before surgical intervention is undertaken. The method of determining the amount of involvement is to map out the bronchial tree with roentgenograms taken after filling the tree with iodized poppy seed oil 40 per cent (fig. 6). In making bronchograms, all five lobes should be completely filled.

We have been continuously broadening our ideas as to the amount of pulmonary tissue which can be safely removed and the age of patients suitable for surgical treatment. Previously, we felt that older persons were not suitable, but we now have a 64 year old patient in our series who withstood lobectomy well. Pneumonectomy is well tolerated in the younger age groups, but we do not believe that pneumonectomy should be undertaken if there is disease on the other side.

5. Shaw, R. R., and Paulson, D. L.: Pulmonary Resection for Chronic Abscess of the Lung, *J. Thoracic Surg.* **17**:514-522 (Aug.) 1948.

6. Glover, R. P., and Clagett, O. T.: Pulmonary Resection for Abscess of the Lung, *Surg., Gynec. & Obst.* **86**:385-394 (April) 1948.

The cases of bilateral infection offer the most difficult problem. If the disease is extensive on one side and minimal on the other side, removal of the diseased lung on the more involved side, provided it does not require a total pneumonectomy, will usually bring about 80 to 90 per cent improvement in the patient's condition. However, it is important that all the diseased lung on the more involved side be removed.

In some of the cases of extensive bilateral involvement it is best to carry the patient along on medical management. In others bilateral operation may be done.⁷ It is this type of case that prompted Overholt, Woods and Betts⁸ to recommend segmental resection.

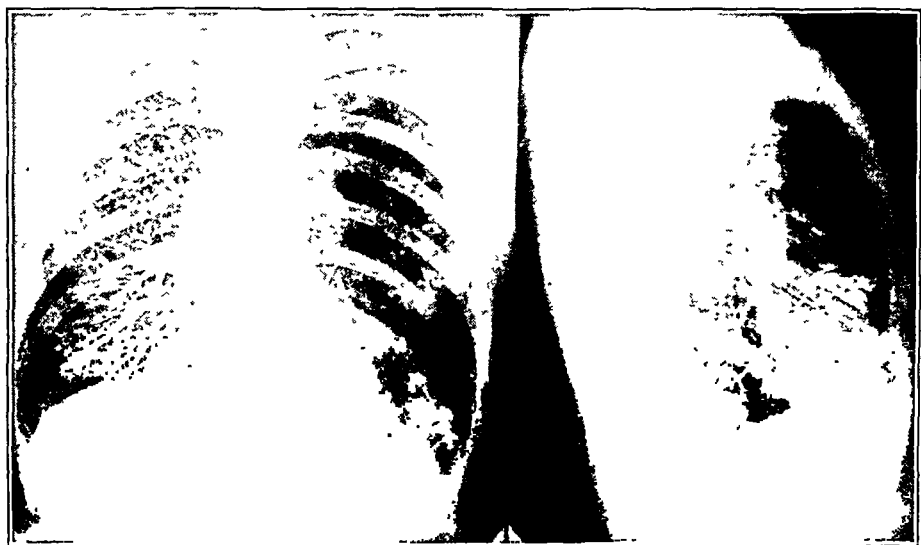


Fig. 6.—Bronchogram showing bronchiectasis of the middle lobe of the right lung. This case illustrates the importance of obtaining complete filling of all lobes.

The operation of segmental resection is based on the anatomic studies of Jackson and Huber⁹ and others, who showed that the lobes are actually subdivided into segments which are in themselves anatomic units with their own blood supply and their own bronchus. If the blood supply and bronchus to the segment are dissected out, that segment can be removed from the remainder of the lobe and the uninvolved pulmonary tissue in the rest of the lobe be preserved.

7. Bisgard, J. D., and Swenson, S. A., Jr.: Bilateral Lobectomy for Bilateral Bronchiectasis, *Arch. Surg.* **54**:483 (May) 1947.

8. Overholt, R. H.; Woods, F. M., and Betts, R. H.: An Improved Method of Resection of Pulmonary Segments, *J. Thoracic Surg.* **17**:464-479 (Aug.) 1948.

9. Jackson, C. L., and Huber, J. F.: Correlated Applied Anatomy of the Bronchial Tree and Lungs with a System of Nomenclature, *Dis. of Chest* **9**:319-326 (July-Aug.) 1943.

The removal of the lingula of the upper lobe of the left lung has been done in many cases since the operation was first suggested by Churchill and Belsey¹⁰ in 1939. Clagett and Deterling¹¹ have described an excellent technic for segmental resection of the lingula. Resection of the lingula has been extremely successful. However, the lingula is in reality a separate lobe corresponding to the middle lobe of the right lung. It is doubtful if such a complete anatomic division exists in the other segments. Although we have performed segmental resections, we feel that there are certain inherent disadvantages of the operation.

From the pathologic standpoint, the chronic pneumonitis associated with bronchiectasis extends throughout the entire lobe and cannot be demonstrated by bronchograms. This extension of inflammatory changes beyond the obviously involved segment is even more pronounced in the case of pulmonary abscess. This remaining pneumonitis would seem to predispose to future bronchiectasis in the remaining segment and impair its future function.

From a surgical standpoint, there are objections to segmental resection. In the separation of the segments, end bronchioles are left open, thus causing air leaks which result in a high percentage of bronchial fistulas and unexpanded lungs. The incident of empyema is greatly increased, being 23.7 per cent in the series of Overholt, Woods and Betts.⁸ In spite of antibiotics, empyema is a complication which adds to the risk of surgical treatment and impairs future pulmonary function. It has been shown repeatedly that the blood supply of the lung is not constant and is characterized by the frequent occurrence of anomalous vessels. In segmental resection, it would seem logical that not infrequently the blood supply to the remaining segment would be interfered with and hemorrhagic infarction and necrosis, with final shrinkage of the remaining segment, would result.

For these reasons we have been reluctant to do segmental resections, except in dealing with the lingula of the upper lobe of the left lung, until further experience shows that the procedure will be entirely satisfactory.

RESULTS

Our results have been good in patients who did not have to be operated on as a lifesaving measure.

Table 3 shows that there were seventy-nine operative procedures performed on 74 patients. Ten of the patients were operated on for

10. Churchill, E. D., and Belsey, R.: Segmental Pneumonectomy in Bronchiectasis: The Lingula Segment of the Left Upper Lobe, *Ann. Surg.* **109**:481-484 (April) 1939.

11. Clagett, O. T., and Deterling, R. A.: A Technique for Segmental Pulmonary Resection with Particular Reference to Lingulectomy, *J. Thoracic Surg.* **15**:227-238 (Aug.) 1946.

drainage of a putrid empyema, which is an emergency operation for a severe complication. In another 10 patients external drainage of a pulmonary abscess was done. Four of these patients had a single acute abscess and recovered without residual disease of the lungs. In the other 6 the abscess was drained externally as an operation of expediency because the patient was not able to stand a resection of the lung at the time. Five of these 6 underwent resection of the lung at a later date. With the exception of the 4 with acute abscesses, in all the

TABLE 3.—*Operative Procedures*

Lobectomy.....	55
Pneumonectomy.....	5
Drainage of pulmonary abscess only.....	4
Drainage of putrid empyema.....	10
Drainage of pulmonary abscess followed by lobectomy.....	5
Total.....	79

TABLE 4.—*Types of Resection*

Lobectomy (entire lobe or lobes removed)	
Lower lobe on left side.....	11
Lower lobe on right side.....	11
Upper lobe on right side.....	5
Middle lobe on right side.....	5
Middle and lower lobes on right side.....	4
Upper lobe on left side.....	4
Segmental Resection	
Lower lobe and lingula on left side.....	12
Lingula alone.....	1
Apical segment on left side.....	1
Basal segments on left side.....	1
Pneumonectomy.....	5
Total.....	60

aforementioned patients the disease had progressed too far. Palliative rather than definitive surgical treatment had to be given, with the result that there were 8 patients with persistent fistulas, 5 of whom required subsequent definitive operations, with 2 deaths.

Tables 4 and 5 show that fifty-five lobectomies and five pneumonectomies were performed in a total of sixty pulmonary resections for suppurative disease of the lungs. All the patients recovered. There were only a few complications, none of which was permanently disabling, and no deaths in this series. The operations were elective so that the patients could be carefully selected for their ability to stand the surgical procedure and carefully prepared for operation at an optimum time.

The point which our results emphasize is that if the patients with suppurative disease of the lungs are carefully followed and vigorously treated from the inception of the disease, the serious complications can be avoided and operations of necessity, which are dangerous operations, will not have to be done.

Resection of the lung can carry a low morbidity and mortality if it is done on patients who are in good general condition. Therefore, the most conservative course seems to be to remove the lung as soon as it is apparent that the disease has progressed to the stage at which it is irreversible.

CONCLUSIONS

Suppurative disease of the lungs results from obstruction to the free drainage of the bronchus plus infection. If the obstruction and infection are allowed to remain for a period of weeks, irreversible damage to the lung in the form of bronchiectasis or abscess will follow.

TABLE 5.—*Results*

	Number	Number of Complications	Atelectasis	Empyema	Bronchial Fistula	Re- covered	Died
Lobectomy.....	55	48	4	2	1	55	0
Pneumonectomy.....	5	4	0	1	1	5	0
Drainage of abscess.....	5	4	..	..	..	4	1
Drainage of empyema.....	10	1	..	10	8	9	1

On the other hand, if free drainage and vigorous treatment with antibiotics are instituted early, the inflammatory process is reversible and the lung will not be permanently damaged. When irremovable obstruction exists or permanent damage has occurred, the treatment is resection of the diseased portion of the lung. As shown by our experience, the removal of diseased pulmonary tissue is no more hazardous than removal of other diseased organs and should be undertaken as soon as a definite diagnosis has been established.

DISCUSSION

DR. A. R. CURRERI, Madison, Wis.: At the Wisconsin General Hospital we would be in practically complete agreement with Dr. Harper. A diagnosis of bronchiectasis shortly after virus pneumonia may cause later embarrassment. During the war I was invited to review some roentgenograms at an army hospital, and I found a group of patients manifesting typical roentgenologic evidence of bronchiectasis. Much to my surprise many of these patients showed no roentgenologic evidence of bronchiectasis three months later. It would appear, therefore, that for a short period following virus pneumonia one may find roentgenologic evidence of bronchial dilatation which does not represent true bronchiectasis. If we accept the theory that the bronchial wall is destroyed in bronchiectasis, we then

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preclude the possibility of a normal bronchogram. We have not encountered such reversible types of bronchiectasis at the Wisconsin General Hospital.

I should like to support Dr. Harper's thesis against segmental resection. Theoretically, segmental resection sounds good; but one often finds considerable pneumonitis throughout the involved lobe, and therefore residual bronchiectasis may be found at a later date in the remaining portion of the lobe after segmental resection.

Furthermore, in the presence of acute inflammatory reaction about the hilus it is often extremely difficult to determine which bronchus is supplying the diseased portion of the lobe. This may result in the removal of the wrong segment or in incomplete resection of the involved segment. Another disadvantage of segmental resection is that often it becomes necessary to leave a long bronchial stump, and the patient, even though partly relieved of symptoms, still has considerable morning cough and expectoration because of accumulation of mucus in the residual stump.

For chronic pulmonary abscess we have continued to favor resection more frequently in the past ten years. This thought is predicated by the fact that even after drainage of peripheral abscess one often finds, at a later date, residual bronchiectasis adjacent to the abscess area.

In cases of unilateral congenital pulmonary cysts we continue to resect the involved lobe or lobes. This type of treatment has the advantage of completely eliminating the pathologic process at one sitting. This approach is used for chronic pulmonary abscess for the same reason, and, in addition, fewer postoperative complications in the form of hemorrhage and bronchopleural fistulas are encountered.

COL. J. H. FORSEE, Denver: These two papers have brought to our attention two very important subjects in the field of thoracic surgery. We have not been as successful at Fitzsimons General Hospital, Denver, in making a preoperative diagnosis in mediastinal tumors as are Dr. Galé and Dr. Curreri. However, we have been firmly of the opinion that these tumors and lesions of nondiagnosed character must be explored. Of some 250 lesions for which exploratory thoracostomies were performed, including lesions in the mediastinum and lung, which were not diagnosed preoperatively, 20 per cent have been found to be malignant.

In regard to suppurative disease of the lung, we are in entire agreement with Dr. Harper's splendid paper and his excellent results. Since March of 1946 we have performed a consecutive series of more than 150 lobectomies for bronchiectasis, in which the lower lobe of the left lung and the lingula, the lower and middle lobes of the right lung or the lower lobes alone and, in a few instances, the upper lobes were removed, without a death.

There was one thing that Dr. Harper did not mention, and I am sure it was only time that prevented it, and that is that chronic suppurative diseases of the lung are not infrequently associated with bronchogenic carcinoma. Therefore, we believe that suppurative diseases must include, in addition to the usual classification, bronchogenic carcinoma.

DR. FRED R. HARPER, Denver: I want to thank Colonel Forsee and Dr. Curreri for their excellent discussions. In answer to Colonel Forsee's question, we excluded the cases of carcinoma, although of course it is well known that carcinoma is one of the common causes of pulmonary abscess. However, we did include the benign tumors which we classed as irremovable obstructions resulting in pulmonary abscess or bronchiectasis.

HERNIA INTO THE UMBILICAL CORD AND OMPHALOCELE (AMNIOCELE) IN THE NEWBORN

CLIFFORD D. BENSON, M.D.

GROVER C. PENBERTHY, M.D.

AND

EDWARD J. HILL, M.D.

DETROIT

THERE has been a tendency to classify congenital malformations of the umbilicus or the supraumbilical region of the abdomen through which there is a herniation of abdominal viscera into a sac covered by peritoneum and amniotic membrane as omphalocele. The use of this all-inclusive term has led to some confusion in evaluating results of surgical treatment.

We feel that the term omphalocele or amniocele should be restricted to those congenital defects in which there is herniation of the abdominal viscera into a sac covered by peritoneum and amniotic membrane through the umbilical and supraumbilical portion of the abdominal wall. In contrast, a hernia into the umbilical cord has a defect limited to the umbilical opening. The defect is practically always less than 4 cm. in diameter, and the sac covered by peritoneum and amniotic membrane usually contains only loops of small bowel. Thus, one can conclude that a hernia into the umbilical cord with its small defect does not present a serious problem to the surgeon, but the true omphalocele with wide separation of the recti muscles and fascia does present a formidable problem in regard to its surgical management.

The incidence of hernia into the umbilical cord and omphalocele has been estimated to be about 1:6,000 births. It is important for the obstetrician to recognize this lesion to avoid damaging the contents of the sac in clamping or tying the umbilical cord. It is essential that operative treatment be undertaken within a few hours after birth because there is a tendency for the amniotic sac to disintegrate or rupture, with resulting peritonitis and subsequent fatal outcome. Unfortunately, omphaloceles have been looked on by some physicians as a situation not remedial by surgical means. This attitude has no doubt been due in part to former attempts at closure of these defects

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From the Surgical Services of the Children's Hospital of Michigan, Harper Hospital and Wayne University College of Medicine.

by layer closure in one stage which resulted in the loss of the infant in twenty-four to forty-eight hours from respiratory or circulatory embarrassment. These infants tolerate ether anesthesia and operative intervention when judgment is used as to whether a one or a two stage type of closure should be adopted.

EMBRYOLOGIC ASPECTS

There have been many theories in regard to the etiology of omphalocele, the most common of which have been the following: 1. The formation of an omphalocele is probably due to an arrest or retardation in the development of the abdominal cavity at the third month of fetal life.¹ The authors who propose this theory feel that the abdomen does not develop rapidly enough and therefore some abdominal viscera will remain in the base of the umbilical cord because of insufficient room within the abdomen. 2. It is thought to occur in the third month of fetal life, the cause being due to the disparity between the abdominal cavity and the abdominal viscera which has resulted from retarded development of the abdominal parietes.² 3. Probably the most important and significant contribution has been that made by Margulies,³ who based his opinions largely on the work of Pernkoff, Politzer and Sternberg. The latter authors studied the formation and closure of the anterior abdominal wall in normal human embryos. Margulies, from a review of this excellent work, stated that this structural defect is confined to the third week of embryonal development, while the formation of hernias into the umbilical cord develops in the eighth to tenth week and shows normal anatomy of the upper abdominal aponeurosis and the recti muscles. Pernkopf's work, as reviewed by Margulies,³ demonstrated that the recti muscles do not take an active part in closure of the abdominal wall but remain V shaped and diastatic even after closure of the umbilical ring and retraction of the intestine from the extracelomic cavity, and he concluded that once the supra-umbilical part of the abdominal wall has been formed normally in the third week of fetal life no herniation covered by amnion can develop at this location.

HERNIA INTO THE UMBILICAL CORD

Hernia into the umbilical cord is a herniation of abdominal viscera through the umbilical ring. The sac is covered by peritoneum and

1. Gross, R. E., and Blodgett, J. B.: Omphalocele (Umbilical Eventration) in the Newly Born, Surg., Gynec. & Obst. **71**:520, 1940.

2. Ladd, W. E., and Gross, R. E.: Abdominal Surgery in Infancy and Childhood, Philadelphia, W. B. Saunders Company, 1941.

3. Margulies, L.: Omphalocele (Amniocoele), Am. J. Obst. & Gynec. **49**: 695, 1945.

amniotic membrane, but the umbilical defect is practically always 4 cm. or less in diameter. The sac usually contains only loops of small bowel (figs. 1 and 2). A resection of the sac, replacement of viscera into the peritoneal cavity and closure of the umbilical defect present no problem to the surgeon. The repair is that used for the ordinary umbilical hernia. The prognosis is excellent in this group as to life and a firm abdominal wall after primary layer closure. Other congenital abnormalities within the sac may alter the prognosis, as illustrated by the patient in case 3 (fig. 3).

In the group of 3 patients with hernia into the umbilical cord, the defect in the umbilical ring measured 4 cm. in 2 and 3.5 cm. in the other.



Fig. 1 (case 1).—Hernia into umbilical cord showing evisceration of the small bowel because of rupture of the amniotic sac at the time of delivery.

In 2 of the patients (cases 1 and 2), who were brother and sister with an interval of two years between their births, there was a herniation of multiple loops of small bowel. One patient (case 1) had a rupture of the sac previous to coming to the operating room. In these patients the sac was excised and the loops of small bowel replaced in the peritoneal cavity, primary layer closure was accomplished with no tension and uneventful recovery occurred. The third patient in this group (case 3) had a defect of 4 cm., but within the sac, in addition to small bowel, there was a large Meckel diverticulum and atresia of the terminal ileum. The sac and Meckel's diverticulum were excised and an ileoileoanastomosis performed, the atresia being sidetracked. The postoperative course was satisfactory for forty-eight hours, when distention and a shocklike syndrome developed. After supportive treat-

ment the abdomen was reopened, and gangrene of the ileum secondary to volvulus and mesenteric vascular occlusion was found. The infant's condition precluded any attempt at resection, and death ensued. Post-mortem examination revealed (1) anomalies of the left carotid artery,

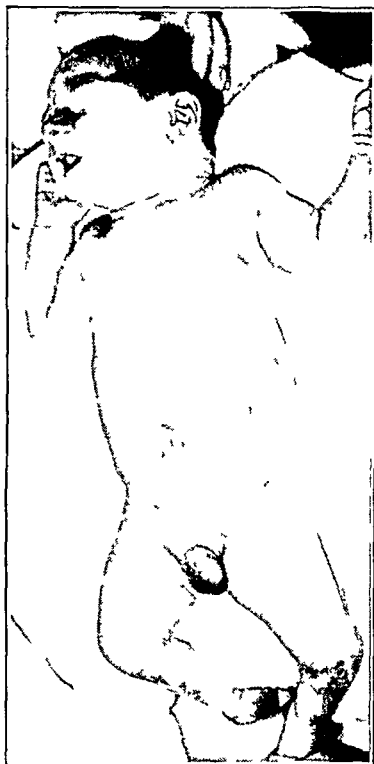


Fig. 2 (case 1).—Photograph of patient one week after surgical excision of sac and primary closure of the umbilical defect.



Fig. 3 (case 3) —On preoperative examination this appeared to be a simple hernia into the umbilical cord, but at operation, four hours after delivery, the sac contained not only small bowel but a large Meckel diverticulum and atresia of the terminal part of the ileum.

(2) patent ductus arteriosus, (3) volvulus of the intestine, (4) atresia of the terminal ileum, (5) gangrene of the ileum secondary to mesenteric vascular occlusion and (6) intraperitoneal abscess.

OMPHALOCELE (AMNIOCELE)

Omphalocele or amniocele is a herniation of abdominal viscera through a defect which includes not only the umbilical ring but the supraumbilical portion of the abdominal wall, with wide separation of the recti muscles and fascia and the sac covered by peritoneum and

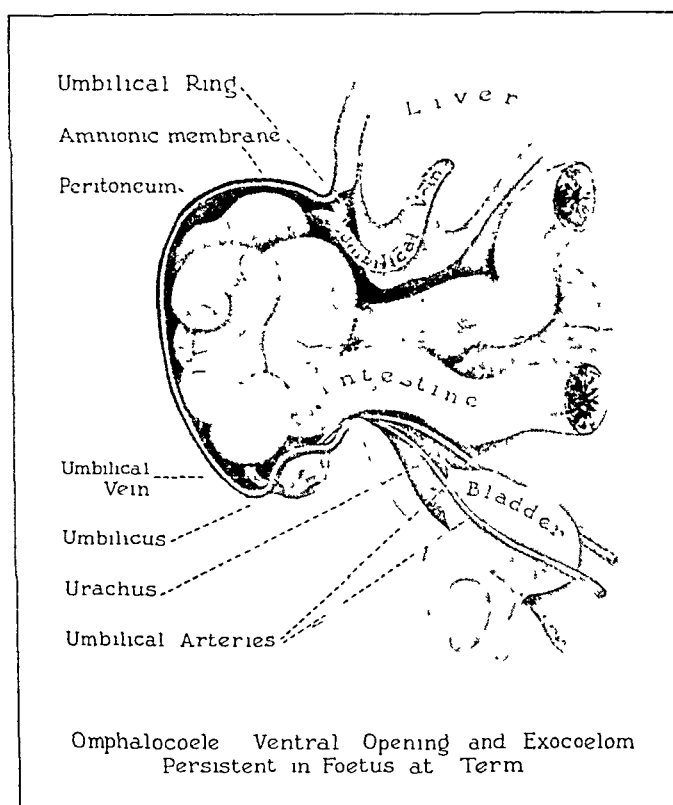


Fig. 4.—Ventral opening and exocoelom persistent in fetus at term.

amniotic membrane⁴ (fig. 4). This lesion presents a formidable problem to the surgeon. It has been emphasized that prognosis is determined largely by the size of the defect in the abdominal wall. We agree that this is true, especially if one attempts to replace abdominal viscera into the peritoneal cavity and primary layer closure. The mortality has been high because the abdominal viscera have been outside of the general peritoneal cavity during intrauterine life and the peritoneal cavity at

4. Ferguson, J. A.: Omphalocele, Persistent Omphalomesenteric Duct and Meckel's Diverticulum, *Univ. Hosp. Bull., Ann Arbor, Mich.* **14**:47, 1948.

the time of birth is too small to contain them. Death from attempts at primary closure in layers has been due to tension created within the abdomen, with subsequent respiratory and circulatory failure in twenty-four to forty-eight hours postoperatively. To reduce the mortality in this group, two stage closure of the defect is of paramount importance.

In the group of 4 patients operated on for true omphalocele, liver was present in the sac in addition to loops of bowel. It has been stated by Ladd and Gross² that the presence of liver in the sac usually means

Data on Patients with Hernia into Umbilical Cord and Omphalocele

Hernia Into Umbilical Cord							
Sex	Weight	Hours Elapsed Before Opera- tion	Abdominal Defect		Operation	Additional Defects	
	Lb. Oz.		Diameter	Contents of Sac			
M	8 10	2	4 cm.	Small bowel	Excision, layer closure	Ruptured sac, eviscera- tion	
F	8 9	2	3.5 cm.	Small bowel	Excision, layer closure	None	
F	7 10	4	4 cm.	Small bowel	Excision of sac and Meckel's diverticulum; ileocolic anastomosis	Patent ductus; Meckel's diverticulum; atresia	
Omphalocele							
F	8	3	8 cm.	Liver and small bowel	Excision, first stage closure	Absence of ligaments of liver	
M	8 3	8	5 cm.	Liver and small bowel	Excision, first stage closure	Omphalomesenteric duct congenital absence of left radius of second and third digits; facial paralysis	
M	6 10	8	7 cm.	Liver, small bowel and stomach	Excision, first stage closure	None	
M	4 1	5	8 cm.	Liver, small bowel, stom- ach and large bowel	Closure impossible	Meckel's diverticulum; atresia; premature, 8 mo.	

and stage layer closure was done at the age of 22 months; the result was satisfactory.

a poor prognosis. Of 8 of their patients who had some part of the liver in the sac, 6 died. Three of the 4 patients in our series who had liver in the sac recovered. It seems to us that the size of the defect as compared to the size and weight of the infant, in addition to prematurity, are factors which may play a prominent role in the prognosis. Also, the judgment exercised as to whether a one or a delayed two stage closure should be used in closing these large defects of the abdominal wall plays an outstanding role in influencing the prognosis.

The one death in this group (case 7) was that of a premature infant, weight 4 pounds 1 ounce (1.8 Kg.), with a defect measuring 8 cm. in diameter. The sac contained all the small bowel, colon, stomach and liver. In addition, there were a Meckel diverticulum

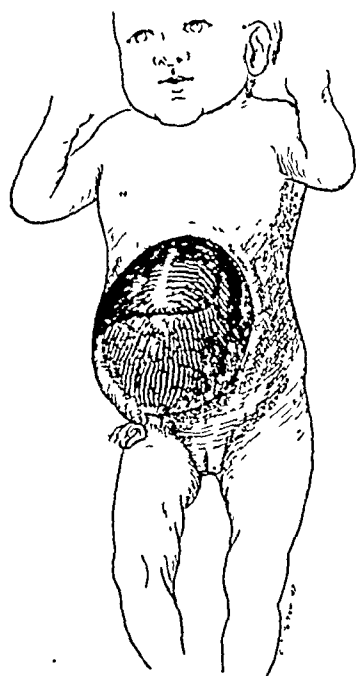


Fig. 5 (case 4).—Drawing of defect at birth. The sac contained small bowel and all the liver.



Fig. 6 (case 4).—Photograph of patient three months after primary stage closure showing residual defect in supraumbilical portion of abdomen.

and atresia of the small bowel. After resection of the amniotic sac and ligation of the umbilical vessels, the skin and subcutaneous tissues were widely undercut, but even after this procedure it was impossible to obtain an approximation of the skin over the herniated viscera.



Fig. 7 (case 5)—*A*, photograph taken preoperatively showing a large defect of the abdominal wall, the sac containing nearly all the liver and small bowel *B*, lateral view of same patient preoperatively. Note that the defect is limited to the umbilical and supraumbilical portions of the abdominal wall.



Fig. 8 (case 5)—Photograph taken at time of operation showing persistent omphalomesenteric duct

In case 4, in addition to the large defect containing the liver and small bowel, it was noted at operation that there was a deficiency in the ligamentous support of the liver (absence of coronary and teres

ligaments, fig. 5). The round ligament was, therefore, anchored under the costal margin, and the right lobe of the liver was sutured to the peritoneum laterally for support. The convalescence was uneventful



Fig. 9 (case 5).—Photograph taken four months postoperatively showing residual hernia after primary stage operation.



Fig 10 (case 6) —Preoperative photograph showing large abdominal defect which extends from the umbilical opening to the xiphoid process. The sac contained stomach, liver and small bowel.

(fig. 6). In case 5, in addition to liver and small bowel being present in the sac (fig. 7), there was also a persistent omphalomesenteric duct (fig. 8). The amniotic sac was excised after ligation of the umbilical

vessels. The opening in the ileum with which the omphalomesenteric duct communicated was closed in the transverse direction. The convalescence was uneventful (fig. 9). The closure of the defect in these 2 patients was accomplished by using only skin and subcutaneous tissue. The infants are now 19 and 15 months old respectively and ready for the second stage layer closure of the residual defect of the abdominal wall.

Case 6 presented the largest defect not only in diameter but in length (fig. 10). Not only the large defect but also the wide separation of the recti muscles and fascia can be seen in the figure. The same pro-

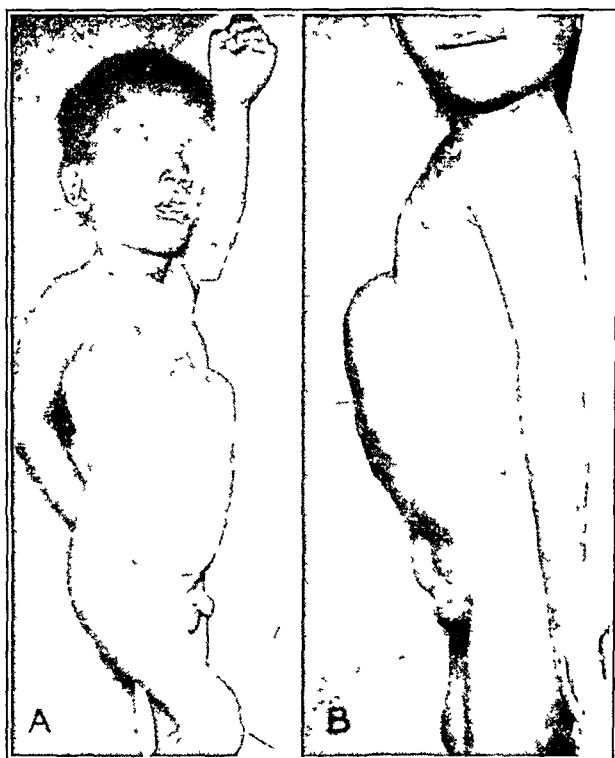


Fig. 11 (case 6).—*A*, photograph taken at an oblique angle showing the large hernia previous to the second stage closure at age 22 months. *B*, lateral view of the same patient.

cedure was carried out as in the 2 previous cases (skin closure) as a first stage operation. Subsequently, this patient was operated on at the age of 22 months, at which time the second stage closure was accomplished in layers with a satisfactory result (figs. 11, 12 and 13).

In a recent publication Gross⁵ has made a contribution to the method of handling omphaloceles of this type. The essential feature

5. Gross, R E : New Method for Surgical Treatment of Large Omphalocele, *Surgery* 24:277, 1948

of his report is that the amniotic sac is not opened at the primary operation but is inverted, and after the skin margins are freed they are approximated over the amniotic sac as a first stage procedure. The purpose of this improvement in technic is to prevent adhesions of the

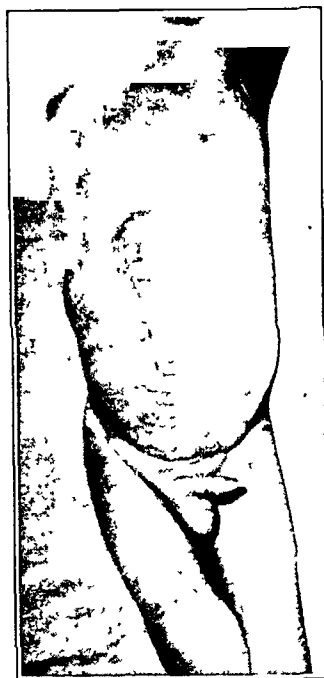


Fig. 12.—Photograph of the same patient ten days postoperatively, showing primary healing of wound, with a firm abdominal wall.

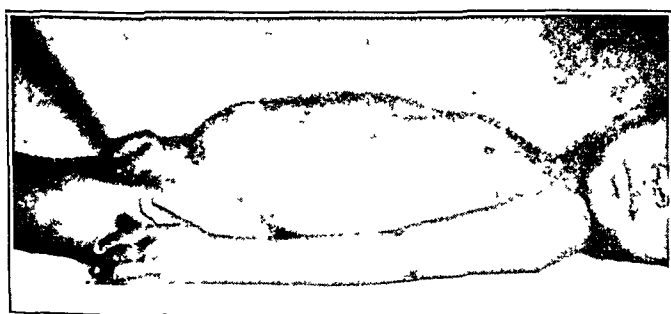


Fig. 13.—Lateral view of the same patient after the second stage layer closure.

abdominal viscera to the subcutaneous tissue and to provide a stronger wall than was provided by only skin and subcutaneous tissue. Gross has also recommended postponing the second stage for some months (six to twelve) to allow the abdominal wall to develop so that the abdominal viscera can be replaced in the peritoneal cavity and the layer closure of the wound accomplished with no tension. It seems

that the benefits of the method described by Gross of inverting the amniotic sac without opening it are outweighed by one significant objection. That is that other intraperitoneal congenital anomalies will be overlooked at the time of operation. To substantiate further this objection, attention is called to the fact that in this series of 4 patients with omphalocele which we are reporting there were four additional intraperitoneal anomalies.

SUMMARY AND CONCLUSIONS

1. Three patients with hernia into the umbilical cord and 4 patients with omphalocele who were operated on within eight hours after delivery have been described. Recovery occurred in 5, the 2 deaths being in infants who had other congenital abnormalities which contributed to their deaths. All these patients have been operated on within the past two and one-half years.

2. Heredity has not been reported as a factor in the incidence of these anomalies. It is to be noted in this series that 2 patients (cases 1 and 2) were brother and sister. There was an interval of two years between their births, and both showed a similar congenital umbilical anomaly at birth, namely, a hernia into the umbilical cord.

3. Omphalocele or amniocele is a herniation of abdominal viscera through a defect which includes not only the umbilical ring but also the supraumbilical portion of the abdominal wall, with wide separation of the recti muscles and fascia and the sac covered by peritoneum and amniotic membrane, and is differentiated from hernia into the umbilical cord.

4. The time of origin of omphalocele is in the third week of embryologic life, whereas hernia into the umbilical cord occurs in the eighth to tenth week.

5. Early operation and the extent of the surgical procedure will be dictated by (*a*) the condition of the patient, (*b*) viscera in the sac, (*c*) coexistent anomalies and (*d*) the size of the defect.

6. The secondary layer closure of the omphalocele is postponed until one is able to reduce completely the abdominal viscera contained in the bulge of the abdominal wall subsequent to the first stage skin closure. This period will vary from six to eighteen months depending on the size of the defect and the growth of the abdominal wall structures.

7. The use of primary skin closure and delayed secondary layer repair of these large defects of the abdominal wall will reduce the high mortality and provide a method for obtaining a satisfactory anatomic result.

DISCUSSION

DR. C. W. McLAUGHLIN, Omaha: I should like to report briefly an unusually large omphalocele which presented a problem in therapy. The child, a twin, was seen on the fifth day of life. Its weight was 4 pounds (1-8 Kg.). The abdominal defect which presented was 10 cm. in its transverse diameter and approximately 12 cm. in its vertical diameter. The opaque covering of the omphalocele showed early necrosis, particularly about the cord. The child was dehydrated, and after suitable preparation an effort was made to return the content of the sac to the abdominal cavity. The sac was seen to contain practically the entire liver and bowel, the abdominal cavity being very immature. When the liver was returned to the abdomen, there was no room for the bowel. Accordingly, the bowel was placed within the peritoneal cavity and approximately two thirds of the liver could be replaced within the abdomen, the remaining third protruding outside. Closure of the abdominal muscles and skin was out of the question, and the skin was tacked to the capsule of the liver, which was actually a portion of the omphalocele sac. A dressing using flamed adhesive tape was then applied over the liver to exert gradual pressure. The child did remarkably well and began to gain in weight and strength, and three weeks after operation was progressing satisfactorily. Twenty-six days after operation, without notice, the child suddenly became cyanotic, with irregular respirations, and succumbed within a period of approximately twelve hours. Autopsy showed healed peritonitis and atelectasis at the base of the left lung, with questionable pneumonia. The heart was in a transverse position but showed no congenital lesion. The postmortem diagnosis was immaturity and atelectasis with possible pneumonia, no other cause for death being found.

This case is presented for the reason that the method used may have some inherent advantage in instances in which exteriorized viscera cannot be returned to the abdomen.

DR. GROVER C. PENBERTHY, Detroit: This paper brings to our attention an important congenital condition which must be dealt with, as Dr. Benson has said, in the first few hours of life. In some cases obstetricians who see these conditions perhaps are of the opinion that they are inoperable. It does appear sometimes a little discouraging to see this tremendous omphalocele, and one wonders at the time if the closure can be accomplished.

In the differentiation between hernia into the umbilical cord and omphalocele it is apparent that the hernia into the umbilical cord must be handled and can be handled early, whereas the omphalocele can be closed by a two stage type of procedure.

The work of Dr. Gross, as mentioned, is constructive, but we are of the opinion that other anomalies will be overlooked. Yesterday Dr. Potts emphasized the importance of considering more than one congenital anomaly when one is dealing with what appears to be just one. Therefore, as Dr. Benson emphasized, we think this amniotic sac should be resected and the abdominal contents explored to see if other anomalies are present, as in the case described with an atresia of the ileum in addition to the omphalocele.

I am sure we are going to see more and more of these cases. Why I am unable to state. The cases all have been observed within the last two and a half years, and it is unusual even to see an occasional omphalocele. It will be interesting for Dr. Benson to bring up this type of case at some future meeting, and it also will be interesting to us to have any of you who have had occasion to deal with these omphaloceles give us information regarding your experience.

DR. JACOB K. BERMAN, Indianapolis: I have been interested in Dr. Benson's excellent presentation. It has been my fortune to see many congenital anomalies in the newborn. In about one fourth of the cases they are multiple. Perhaps this figure would be much higher if we include minor defects which are not always apparent. In our experience multiple anomalies are less apt to occur in association with malformations of the foregut than with malformation of the midgut or hindgut. It has been my observation in congenital atresia of the esophagus, for example, that there is less likely to be associated anomalies. The same thing is true of congenital atresia of the biliary duct system, the stomach or the duodenum.

With regard to the specific problem at issue this morning, what I have to say is simply fortuitous, because Dr. Benson has covered the subject extremely well. The fifth to the ninth week of intrauterine life is a precarious time in our existence when almost the entire midgut lies outside of the abdominal cavity.

I agree with Dr. Benson and Dr. Penberthy that in association with omphalocele one is apt to see multiple anomalies, and I wish to report 2 cases which I have taken care of within recent months. One of the babies left the hospital just before I came to this meeting. These two cases are unusual because in 1 the transverse mesocolon was attached to the superior margin of the omphalocele. You will remember that the foregut gives rise to the alimentary canal from the mouth down to the duodenal papilla and is supplied by the celiac axis; its function is digestion. The midgut forms the canal from the duodenal papilla to the middle of the transverse colon and is supplied by the superior mesenteric artery; its function is absorption. The hindgut may be described as that portion of the bowel from the middle of the transverse colon to the anus, and it is supplied by the inferior mesenteric artery; its function is excretion.

We are dealing here with an anomaly of the midgut, and the transverse mesocolon in this case was densely adherent to the superior portion of the sac. In dissecting this loose one must be extremely careful in order to avoid injury to the middle colic artery, which constitutes the blood supply of the transverse colon. Furthermore, by being attached to the superior margin of the sac, the midgut cannot rotate in its normal direction, and therefore in 1 of these cases the ascending colon and cecum were on the left side of the abdomen; the ileum entered the cecum from right to left, and there was an associated Meckel's diverticulum and a patent urachus.

In the other there were three atresias of the terminal end of the ileum, which required resection and anastomosis between the ileum and the ascending colon. Fortunately the children did recover. In the case of a large omphalocele, it is better not to open the amniotic-peritoneal sac in search for associated defects. Instead, the skin should be widely mobilized as described and brought together, leaving the sac in situ.

DR. GEORGE B. PACKARD, Denver: Dr. Benson and Dr. Penberthy have covered the subject thoroughly, and I particularly agree that the urgency of these operations is vital. I should like to mention 1 case as an example of a complication or at least an additional hazard in omphalocele. As omphalocele represents an arrest at the first stage of rotation, there may be anomalies of the intestinal attachment to cause trouble even after reduction of the contents and repair of the omphalocele.

A baby of about 6 pounds (2.7 Kg.) was born with a rather large protrusion, not covered with skin, which was repaired within a few hours of birth at a general hospital. The baby did fairly well at first but began to vomit at the age of about 1 week. In spite of feeding regulation, she continued to vomit no matter

what the formula or amount or method of feeding. Roentgenograms with barium showed no positive obstruction but a delay of the barium in the stomach and duodenum, with the cecum in the right upper quadrant.

Because of steady loss of weight and poor nutrition at the age of three weeks, the baby, now weighing 4 pounds 14 ounces (2.1 Kg.), was operated on. The findings were a dilated duodenum and attachment of the cecum at the duodenojejunal angle, resulting in partial obstruction. The cecum was freed from the duodenum and from all attachments to the right of the duodenum and placed in the left upper quadrant, thus allowing direct emptying of the duodenum into the jejunum and farther along the entrance of the ileum into the cecum from the right.

The baby has had a stormy course but is slowly gaining, holds most of its feedings and should now, at 6 weeks, get on well.

According to general belief, the small intestine outside the body cavity of the 8 week fetus returns first into the abdomen and is followed later by the colon and cecum. The fact remains that in this case the small intestine was still in the omphalocele, and after its return cecal attachments caused obstruction at the duodenojejunal junction—the typical point for obstruction and volvulus in second stage errors. I present this case, not to suggest any changes from the presented method of treatment, but to add that other intestinal defects may also exist and require surgical attention.

This roentgenogram shows the dilated duodenum and the jejunum, which has an obstruction between the duodenum and jejunum.

DR. EDWIN M. MILLER, Chicago: The important points in the treatment of omphalocele in the newborn have been clearly brought out by Dr. Benson and Dr. Penberthy. The necessity for early operation is, of course, obvious, but I believe there is room for disagreement about the wisdom of opening the cellophane-like covering of peritoneum and of making an exploration for other possible anomalies, as they have suggested. True enough, several errors in development sometimes do occur together, but I would much prefer to take my chances on there being no other anomaly present and accomplish successfully the main, immediate objective, and that involves undercutting widely separated margins of the skin and bringing them together over the intact unfolded peritoneum. This point is well illustrated by these few colored slides of an infant girl on whom I operated in 1933 a few hours after birth. The future link, as in all these cases, was under some tension, the stitches gradually gave way and the granulating surface this produced slowly became covered by a rough, thick epithelium. It is well to remember that there need be no hurry about performing the second operation. In this case we allowed four years to elapse, and during that period the child wore a snug abdominal binder which effectively prevented any bulging in this region, so that in 1937 it was an easy matter to make an imbrication of the available tissue layers, after excision of the rough redundant skin, and thus secure a result which at this time (fifteen years after the birth) is entirely satisfactory.

DR. CLIFFORD D. BENSON, Detroit: I have nothing further to add. I wish to thank the various discussers for the points they have brought out.

THUMB TRACTION TECHNIC FOR REDUCTION OF COLLES' FRACTURE

RALPH G. CAROTHERS, M.D.

CINCINNATI

AND

FOSTER J. BOYD, M.D.

INDIANAPOLIS

UP UNTIL the late 1920's the principles of treatment of Colles' fracture centered about forceful manual manipulation followed by immobilization in volar flexion and ulnar deviation with a padded plaster cast. Longitudinal traction, though recognized as of varying importance, played a comparatively minor role in the reduction. With the advent of Böhler's technic in 1929,¹ involving strong longitudinal traction of thumb and fingers against the fixed and flexed upper arm, came a marked change in the principles of treatment. By this method, hyperextension to break up impaction was eliminated and manual molding could be reduced to a minimum. We feel that strong traction in the longitudinal axis of the radius is an adequate means of overcoming radial impaction and dorsal displacement, though a certain amount of molding may be necessary to complete the reduction. By the use of the unpadded plaster cast, extreme volar flexion and ulnar deviation are unnecessary to maintain reduction of fragments.

After the acceptance of Böhler's principles by many surgeons, numerous devices were invented for putting them into effect. The original technic of the exertion of manual traction on the thumb and fingers by an assistant after both the patient's and the assistant's hands were coated with mastisol® (a solution of mastic) or benzoin entailed several disadvantages. Constant and unaltered traction was difficult to maintain and depended largely on the strength and steadiness of the assistant. A solution to this problem was reached when Caldwell, in 1931, ingeniously brought forth the "finger traps."² By applying these wire traps to thumb and fingers, fixed traction could be maintained without the aid of an assistant and without endangering the circulation to the fingers.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 4, 1948.

1. Böhler, L.: *The Treatment of Fractures*, translated from the German, Baltimore, William Wood & Company, 1936.

2. Caldwell, J. A.: *Device for Making Traction on Fingers*, J. A. M. A. 96:1226 (April 11) 1931.

In first applying this technic, the authors and their associates used the thumb and all four fingers for traction. Gradually, however, it was found that the use of the thumb, index, middle and ring fingers was sufficient. Then evolved the use of just thumb and index and middle finger, with less pull on the fingers, and finally the use of the thumb alone. This gradual evolution of procedure has occupied the last sixteen years and has entailed the trial of various modifications of Böhler's technic. The final method, which we shall now describe, has been used successfully for the past eight years in a gradually increasing percentage of cases and with gradually increasing satisfaction.

TECHNIC

Local injection of 10 to 20 cc. of 1 per cent procaine hydrochloride into the dorsal aspect of the fracture hematoma is the anesthesia of choice.

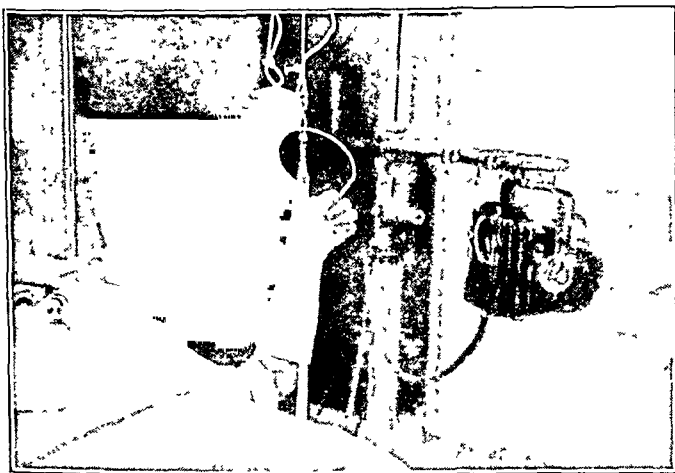


Fig. 1.—The cast has been applied, but the traction is still on. Note how the x-ray machine can be brought close in any direction. The loop of rope which comes out at the top and bottom is merely a guide for splitting the cast on the ulnar side.

With the patient lying flat on the orthopedic table, the arm is abducted to 90 degrees and fixed countertraction applied by means of a canvas sling over a felt pad on the upper part of the arm. A 6 cm. length of stockinet is applied to the upper part of the forearm to prevent trauma to the skin from the upper end of the cast. After the application of a single finger trap to the thumb, the elbow is flexed to 90 degrees with the forearm vertical. The cord from the finger trap is placed through a slot in the end of an overhead cross bar. This bar extends parallel to and approximately 3 feet (91 cm.) above the upper part of the arm. By gradual turning of the overhead cross bar the cord to the finger trap is tightened and traction to any desired amount is exerted on the thumb. If desired, a spring scale can be incorporated between

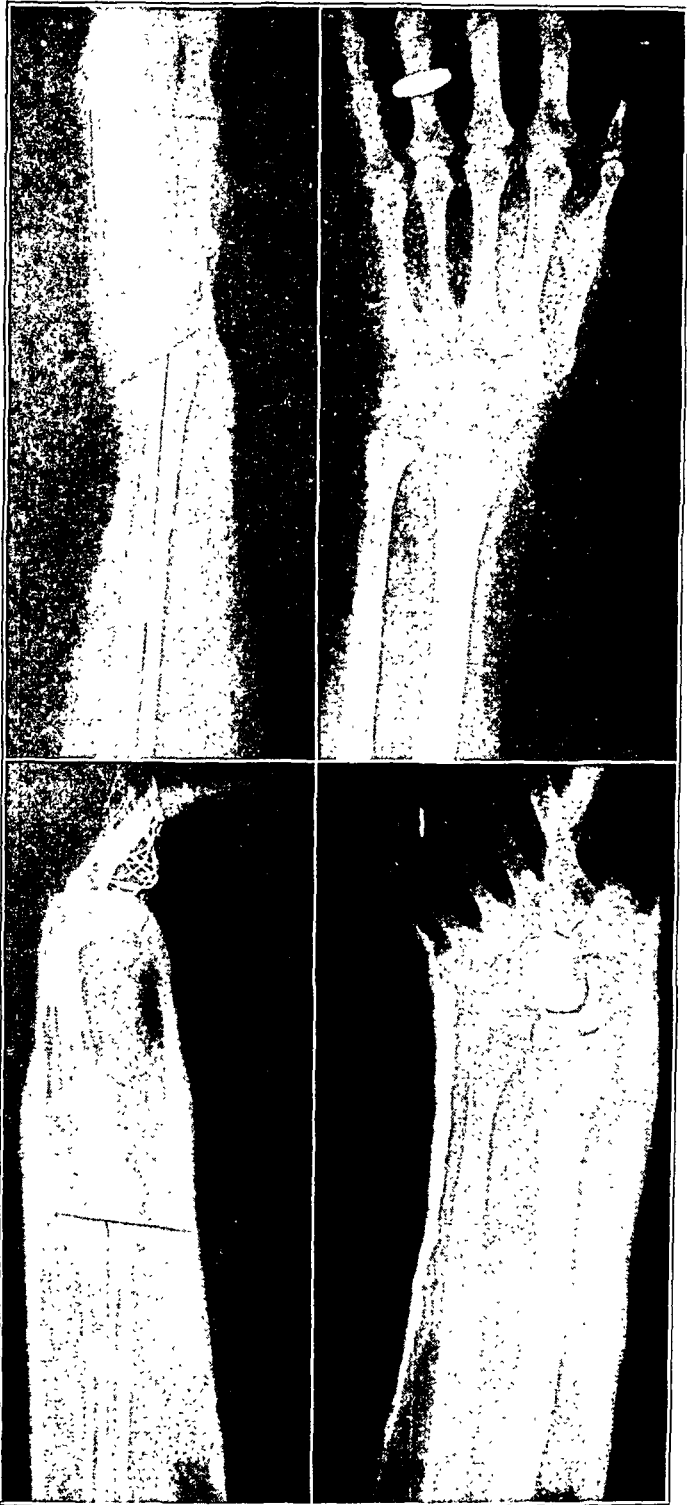


Fig. 2.—Roentgenograms in a typical case. Above, before reduction; below, after the cast has been applied, showing how straight traction on the thumb only has corrected the deformity and given a reasonable amount of ulnar deviation.

the finger trap and its cord. It can be seen that in this manner traction is exerted directly in the longitudinal axis of the radius, with a certain amount of ulnar deviation necessarily resulting. After five to fifteen minutes of traction, fluoroscopic examination is made, and if reduction is not complete, gentle manipulation and molding usually effect a satisfactory reduction.

With the use of a single roll of 5 inch (12.7 cm.) plaster bandage for the entire cast, a longitudinal splint is first made with approximately half the bandage and placed on the radial aspect of the forearm. A narrow strip of sheet wadding is next applied to the ulnar side of the forearm, and over it is placed a length of rope somewhat longer than the cast.³ A small piece of sheet wadding is placed between the thumb and forefinger. With the remainder of the plaster roll a skin-tight circular cast is applied from the horizontal palmar crease to approximately 9 cm. distal to the olecranon. Several layers of plaster are brought between the thumb and index finger to hold the first metacarpal bone in position. When the plaster has set, a split is made in the cast along the ulnar side, through which the length of rope is removed, thus eliminating the possibility of undue constriction. Finally, the cast is wrapped with several layers of wet roller bandage and the arm released from traction. Anteroposterior and lateral roentgenograms are made for permanent record. The patient is instructed to begin active exercise of the fingers, elbow and, particularly, the shoulder at once. Check-up roentgenograms may be made after one week, and the cast is removed after seven to eight weeks.

ADVANTAGES OF REDUCTION METHOD

1. In a large percentage of cases, traction on the thumb only achieves satisfactory reduction.
2. Trauma to the soft tissues of the wrist is reduced to a minimum.
3. The entire procedure can be done by one person, with the aid of an x-ray technician.
4. The wrist is readily accessible to the portable x-ray machine because of minimal obstruction from apparatus and assistants and constant immobilization of the forearm.
5. The vertical position of the forearm eliminates the greater or lesser amount of displacement which might result from gravity if the traction were exerted horizontally.
6. Application of the cast is facilitated by the immobilization (mechanical) of the forearm.

ADVANTAGES OF METHOD OF CAST APPLICATION

1. The possibility of undue constriction of the forearm is eliminated. (Patient can cut roller bandage over split in cast to release pressure if necessary.)
2. Application is quick and simple.
3. A minimum of material is necessary.
4. The cast is thick on the radial surface, where strength is most needed, and thin on the ulnar surface.
5. The only limitation of motion is at the wrist, which eliminates the possibility of a stiffened hand, elbow and shoulder.
6. The cast is light and not cumbersome.

DISCUSSION

DR. RALPH G. CAROTHERS, Cincinnati: The reason we felt called on to write this paper is that in some clinics we have seen demonstrated methods of reducing Colles' fracture which required a good deal of assistance. In other words, it took several persons to handle the patient. Our second reason was that it has always hurt our feelings to believe that a thing had to be made worse before it could be made better. We are referring, of course, to the severe dorsal flexion that is carried out by some surgeons with the idea of disimpacting the fragments. The slides show that with thumb traction only we have been able to disimpact the fragments and line them up nicely, and we have been able to do this without the assistance of any second person and get the cast on easily.

DR. KELLOGG SPEED, Chicago: Dr. Carothers, in his effort to improve fracture treatment, has again exhibited his thoughtful work. You must admit that this method is efficacious. It depends, certainly, on the integrity of the radiocarpal, the carpal and the metacarpal-carpal ligaments. Were they not intact, this method would fail because there would be no method of traction on the lower or distal end of the radius.

He has thus, by traction, complied with the criteria of reduction, namely, the reduction of the silver fork deformity, the restoration of the relationship of the styloid processes of the two bones and finally the restoration of the looking forward and downward angle of the radiocarpal joint.

I have used this method in the past only in cases of old or ancient fractures with deformity, in which I had to do an osteotomy on the radius to loosen it up and to try to get it back into better position. Certainly it works well in such cases, combined with skeletal traction through the thumb to a banjo splint. I have never had to use it in a recent or fresh case, but I may in the future.

DR. FOSTER J. BOYD JR., Indianapolis: I have nothing to add; I merely wish to thank Dr. Speed for his constructive discussion.

CLASSIFICATION AND TREATMENT OF TROCHANTERIC FRACTURES

HAROLD B. BOYD, M.D.

MEMPHIS, TENN.

AND

LAWRENCE L. GRIFFIN, M.D.

AUSTIN, TEXAS

THE PURPOSE of this paper is to present the data obtained from the study of 300 trochanteric fractures of the femur treated by the staff of the Campbell Clinic. The results obtained by internal fixation are compared with those following nonoperative methods. A classification is given based on prognosis and the difficulty of securing and maintaining reduction. The number of cases was arbitrarily limited to 300 to facilitate calculation of data. These were as nearly consecutive as possible, consistent with the availability of roentgenograms and completeness of records. All were private patients and most were treated at the Campbell Clinic, since a complete series of roentgenograms was not always preserved at other hospitals. Avulsion fractures of the greater or lesser trochanter were excluded.

A number of classifications of trochanteric fractures are recorded in the literature. These have generally been based on the anatomic site of the fractures. Stuck¹ (using Boehler's classification), Moore,² Briggs and Keats³ and others classified trochanteric fractures primarily from an anatomic standpoint. Key's⁴ and Myron Henry's⁵ classifications were devised as guides to the use of various types of internal fixation.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 4, 1948.

From the Campbell Clinic and the Department of Surgery, University of Tennessee, Memphis, Tenn.

1. Stuck, W. G.: The Treatment of Intertrochanteric Fractures of the Femur, *Surgery* **15**:276 (Feb.) 1944.

2. Moore, J. R.: Fractures of the Upper End of the Femur Including Fracture Dislocation at the Hip Joint, *Am. J. Surg.* **44**:117 (April) 1939.

3. Briggs, H., and Keats, S.: Management of Intertrochanteric Fractures of the Femur by Skeletal Traction with the Beaded Kirschner Wire, *Am. J. Surg.* **71**:788 (June) 1946.

4. Key, J. A.: Internal Fixation of Trochanteric Fractures of the Femur, *Surgery* **6**:13 (July) 1939.

5. Henry, M. O.: Intertrochanteric Fractures, *Minnesota Med.* **26**:690 (Aug.) 1943.

In the study of this series, the cases were grouped according to the relative ease or difficulty of securing and maintaining reduction; this, we feel, provides information of value in planning the treatment and estimating the prognosis. Four types were designated.

Type I designates fractures showing a more or less linear break extending along the general direction of the intertrochanteric line from greater to lesser trochanter (fig. 1). In this group reduction is usually simple and maintained with the least difficulty.

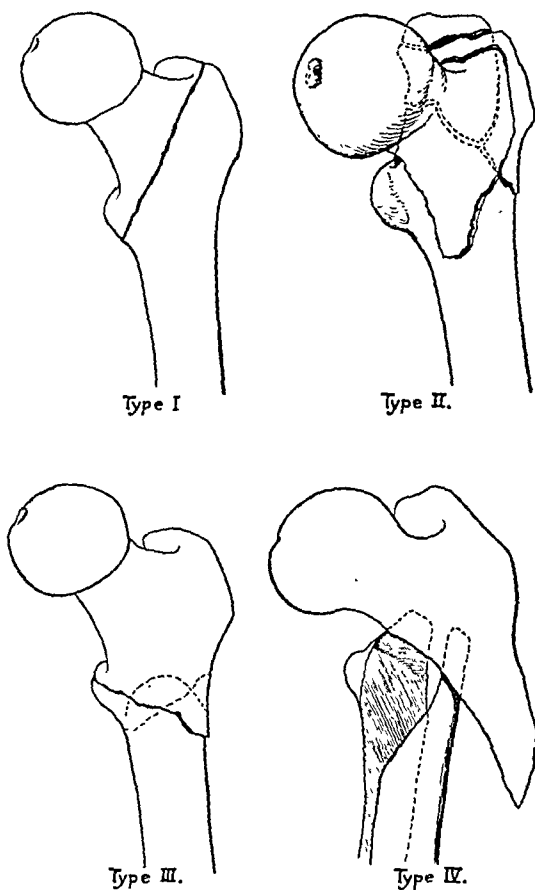


Fig. 1.—Types of trochanteric fracture.

Type II designates fractures which are comminuted, with the main line of fracture being along the intertrochanteric line but with multiple breaks occurring in the cortex (fig. 1). Here reduction is more difficult. In this type degrees of comminution vary from slight to the extreme. One deceptive form of type II fracture is that which on an anteroposterior roentgenogram appears to be a linear intertrochanteric fracture, or type I, but in the lateral view of the femoral neck and trochanter reveals an additional fracture in the coronal plane.

Type III designates fractures which are essentially subtrochanteric, with at least one fracture line passing across the upper end of the shaft just below or in the region of the lesser trochanter (fig. 1). Various degrees of comminution may be associated with this type. The features seen in either type I or type II may be present in addition to the subtrochanteric fracture. Type III fractures are generally much more difficult to reduce and to maintain in reduction than either of the first two types.

Type IV designates comminuted fractures which extend through the trochanteric region and usually on into the shaft, with fracture

TABLE 1.—*Trochanteric Fractures of the Femur*

Type	Number of Cases	Percentage
I.....	88	29.3
II.....	111	37.0
III.....	80	26.7
IV.....	21	7.0
Total.....	300	100.0

TABLE 2.—*Mortality of Trochanteric Fractures of the Femur*

Age	Number of Cases	Deaths	
		Number	Percentage
Under 59.....	62	0	0
60 to 69.....	48	4	8.33
70 to 79.....	118	19	16.1
80 to 89.....	60	23	38.3
90 to 96.....	9	7	77.8
Exact age unknown.....	3	1	33.3
Total.....	300	54	18.0

lines in at least two planes. In the event open reduction and internal fixation are employed, these fractures require two plane fixation.

The frequency of the four types is noted in table 1. Fortunately the most difficult fractures to manage, types III and IV, constituted only 33.7 per cent of the entire series.

Ninety and seven-tenths per cent of the patients were over 50 years of age, with the average age for the series being 69.7 years. The mean age (representing 39.7 per cent of all the patients) was 70 to 79 years of age. A marked sex difference was seen; 226, or 75.8 per cent, of the patients were females and 74, or 24.2 per cent, were males. None of the patients had more than one trochanteric fracture, but patients were included in the series who had a fracture of the femoral neck on one side and a trochanteric fracture on the other, not simultaneously.

Additional fractures were seen in 25, or 8.3 per cent, of the patients; sixteen of these were Colles' fractures and nine were other fractures.

The mortality rate was 18 per cent, 54 deaths in 300 cases. The mortality rate by decades is shown in table 2. As shown, no deaths occurred in patients under 60 years of age. The mortality rate increased with each decade to 77.8 per cent in the tenth decade. A breakdown of mortality following the four main types of treatment used is shown in table 3. It is of interest to note that although a greater proportion of patients die after internal fixation during the first month, 13.3 per cent

TABLE 3.—*Mortality in Types of Treatment of Trochanteric Fractures of the Hip*

Type of Treatment	Number of Cases	Under 1 Mo.	Under 3 Mo.	After 3 Mo.	Percentage
None.....	8	4	0	0	50
Traction.....	6	0	1	0	16.7
Casts.....	77	7	6	1	18.2
Internal fixation.....	209	28	6	1	16.7
Total.....	300	39	13	2	18.0

TABLE 4.—*Types of Treatment for Trochanteric Fractures of the Hip*

Treatment	Number	Percentage
None.....	8	2.8
Traction.....	6	2.0
Casts.....	77	25.7
Nonoperative.....	91	30.5
Neufeld nail.....	164	54.5
Jewett nail.....	28	9.3
Other types of internal fixation.....	17	5.7
Operative.....	209	69.5
Total.....	309	100.0

as compared with 9 per cent of those treated by casts, the total mortality rate, including deaths known to have occurred at least in the first three months after injury, showed a lower rate, 16.7 per cent in the operative group as compared with 18.2 per cent of those treated by casts.

The types of treatment used in these cases are shown in table 4. These data do not represent the present policy toward the treatment of trochanteric fractures. The nonoperative group, 30.5 per cent, largely represents the patients treated in the earlier years included in this study. At the present time the vast majority of patients are treated by operative methods. Since the Jewett nail has been used only during the past two and a half years, it is now being used in a larger percentage of patients than indicated in the table.

In the patients listed as having no treatment a Thomas splint with adhesive traction was applied to the involved leg, but no further measures were taken, generally because the patient's condition was too poor to warrant more aggressive treatment. Four of these patients died shortly after admission to the hospital, and 2 were carried home, with no follow-up information available. In 1 patient union occurred in three months, but with coxa vara deformity. The eighth patient, who had fallen on the hip of an amputated limb, was treated in bed for a month and then allowed up on crutches without wearing his prosthesis; the fracture united without deformity.

Six patients were treated by traction, 2 with skeletal traction and 4 with adhesive traction on Hodgen's splints. One died after three months in traction, 1 was "taken home to die" after seventy-six days, without follow-up, and in 4 the fracture united, with coxa vara in 2. This method was not favored because of the immobility of the patient in bed and the long period of hospitalization required.

Seventy-seven patients were treated in plaster of paris casts. Sixty-six of these were placed in body casts in which a Hoke well leg traction was incorporated, i. e., adhesive traction, beneath the cast on the affected leg, attached to a ratchet to maintain the traction. This method was considered the most satisfactory of the nonoperative procedures, as the patient could be turned over in bed. Also, if the patient's general condition permitted, hospital care would be shortened to a few weeks, provided proper nursing and medical care were available at home.

In the group treated by casts as a whole 14 died—a mortality rate of 18.2 per cent—which compares favorably with Key's report⁴ of a 38 per cent mortality in 214 intertrochanteric fractures treated conservatively. Morris⁶ reported a 44 per cent mortality rate in 16 consecutive cases of trochanteric fractures treated by nonoperative means. Harmon⁷ reported a 39 per cent mortality in 164 cases, and Taylor and others⁸ reported a 25.4 per cent mortality in 114 cases of fractures treated without operation. All the patients in this series were private patients, which had some bearing on the relatively low death rate, as adequate means were available for the proper care of a patient in a body cast. An incidence of coxa vara of 10 degrees or more was noted in 25, or 31.4 per cent, of this group. This developed in spite of closed reduction under anesthesia and after good position was demonstrated by postoperative roentgenograms made through the casts. Nonunion

6. Morris, H. D.: Trochanteric Fractures, *South. M. J.* **34**:571 (June) 1941.

7. Harmon, P. H.: The Fixation of Fractures of the Upper Femur and Hip with Threaded, Hexagon-Headed, Stainless-Steel Screws of Fixed Length, *J. Bone & Joint Surg.* **27**:128 (Jan.) 1945.

8. Taylor, G. M.; Neufeld, A. J., and Janzen, J.: Internal Fixation for Intertrochanteric Fractures, *J. Bone & Joint Surg.* **26**:707 (Oct.) 1944.



Fig. 2—*A*, a comminuted type II fracture which was converted to a type III fracture at the time of operation. *B*, roentgenogram taken in the operating room after the operation. Note that the end of the nail comes within a centimeter of the articular surface. A shorter nail would have been preferable. *C*, result following medial migration of the distal fragments, with penetration of the acetabulum by the Neufeld nail. *D*, result seven months after the operation; the Neufeld nail has been removed. There is bony union, with a good functioning hip.

occurred in 1 patient treated by Hoke well leg traction. Here reduction was demonstrated to be adequate by postoperative roentgenograms except for moderate angulation in the lateral view. At the end of two and a half months there was no sign of union, and the cast was removed and the patient kept in bed. Six months after the first reduction a bone



Fig. 3—*A*, comminuted type III trochanteric fracture. *B*, position of the fragments and the internal fixation following the use of a Neufeld nail and additional plate to prevent medial migration of the distal fragment. *C* and *D*, appearance of the fracture and the internal fixation six months after the operation. The fracture has united in satisfactory position.

graft was done, and union was obtained. Another nonunion developed which required a subsequent bone graft, but this was not necessarily due to the method of treatment, as the patient, a wilful 27 year old man, took his cast off without permission and started full weight bearing at five and a half weeks.

Internal fixation was carried out in 209 patients, or 69.7 per cent, of the series. The Neufeld nail was used in 164 patients and other forms of internal fixation in the remaining 45.

In 4 cases of this series, type I fracture in 1 case and type II in 3 cases, the fractures were converted to type III at the time of operation. The lateral cortex was shattered either by drilling the hole for the nail or at the time the nail was inserted, which produced a subtrochanteric fracture.

In subtrochanteric (type III) fractures medial migration of the distal fragment may occur because of the pull of the adductor muscles. This is especially true if the angle of the Neufeld or Jewett nail is at the same level as the subtrochanteric fracture. Since the plate element of these nails is attached to the shaft of the femur, any medial migration of the shaft fragment forces the proximal portion of the nail deeper into

TABLE 5.—*Loss of Position in Fractures Treated by Internal Fixation*

Type	Number	Coxa Vara	Medial Migration	Type Converted to III	Non- union
I.....	62	4	..	1	1
II.....	76	7	1	3	..
III.....	54	9	9	..	3
IV.....	17	2	..	..	..
Total.....	209	22	10	4	4

the head of the femur. The nail may be forced through the articular surface of the head of the femur and into the hip joint and in some cases through the floor of the acetabulum into the pelvis (fig. 2). To prevent this medial migration we have used additional internal fixation of several types. None has been completely successful. At the suggestion of Dr. Thomas A. Richardson, one of the fellowship men at the Clinic, a "T" or "Y" type of nail has been used. This is accomplished by superimposing a second plate over the vertical portion of the Neufeld nail which extends upward along the lateral surface of the trochanter (fig. 3). This prevents medial migration of the shaft fragment but does not prevent bending of the Neufeld nail and angulation at the fracture site. The Neufeld nail is ideal for type I and II fractures, but it should be made stronger for type III fractures.

Type III fractures are the most difficult to treat. A study of table 5 shows that coxa vara is more common in subtrochanteric fractures than in any other type. Medial migration of the distal fragment was seen in only one type II fracture and in no fractures of types I and IV, while this complication was seen in nine type III fractures. Nonunion is rare in trochanteric fractures. When it does occur it is usually seen in type III fractures. In the 209 patients who were treated by

operation, nonunion occurred in three type III fractures and in one type I fracture.

Eight Neufeld nails bent, and three broke. This weakness is one of the disadvantages of the Neufeld nail. On the other hand, its slight flexibility is an advantage in securing accurate apposition between the plate portion of the nail and the shaft of the femur. In 3 muscular persons in whom it was feared the nail would bend, two Neufeld nails were superimposed. No bending occurred in these patients.

In type IV fractures in which two plane fixation was necessary, reduction was accomplished and stainless steel screws were placed across the fracture line or lines from cortex to cortex before the blade plate was applied. In this series, supplementary internal fixation was used eleven times in addition to Neufeld nails.

Jewett nails were used in 28 cases. These have given satisfactory results, with no instances of breakage of the nail. In these cases, coxa

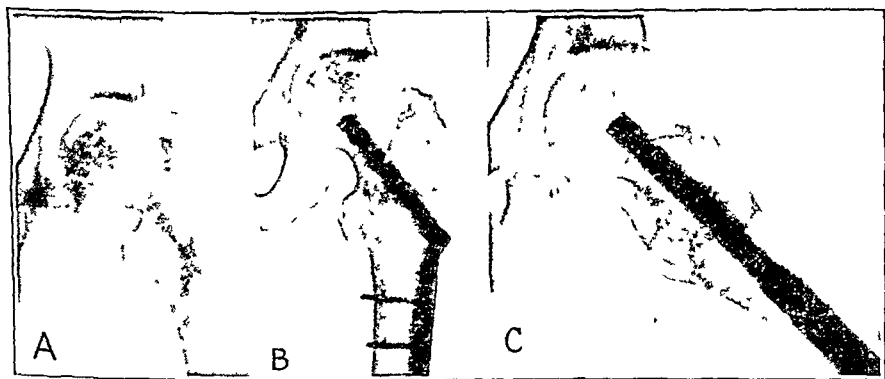


Fig. 4—*A*, comminuted type II trochanteric fracture. *B* and *C*, result six months after insertion of the Jewett nail

vara occurred in only 3.6 per cent of the cases, as compared with 9.7 per cent of cases in which Neufeld nailing was used. The Jewett nail is more difficult to insert, as the guide wire must be in the proper position while the Neufeld nail may be allowed to drift slightly from the guide wire in order to insure proper apposition of the plate to the side of the femoral shaft.

The Moore-Blount blade plate was used in 6 cases. Surprisingly, despite the apparent great strength of the nail, one broke at its angle.

One patient in this series had a complete posterior dislocation of the head of the femur with an associated trochanteric fracture. This patient was treated by open reduction of the dislocation and fixation of the fracture with Knowles pins followed by skeletal traction for sixty-four days. No loss of position occurred.

An analysis was made of the 209 cases in which internal fixation was used and of the results obtained in the different types. As might be predicted, type III fractures proved to offer the greatest incidence of

loss of position postoperatively. In all, there were 9 cases of medial migration of the distal fragment, 9 cases of coxa vara and 17 cases of protrusion of the nail through the head. All three conditions tended to occur simultaneously. Most of these occurred in type III fractures. These factors suggested the need for supplementary internal fixation in some type III fractures. All type III fractures do not require additional internal fixation. Some are stabilized by jagged or serrated fracture lines that prevent migration after accurate reduction. In others a solid bridge of bone between the portion of the nail in the head and neck of the femur and the subtrochanteric fracture will prevent medial migration of the distal fragment. Also, the type II fractures offer some difficulty in maintenance of reduction. In this group there were 7 cases of coxa vara and 1 of medial migration of the distal fragment.

In the series, some of the nails obviously were too long when first inserted, but it is believed that "overdrive," as described by Cleveland and others,⁹ depends also on the type of fracture involved. Type III fractures offered the best opportunity for medial migration of the shaft and nail, permitting protrusion of the nail through the head. A low incidence of postoperative loss of position in the difficult type IV fractures was due to adequate fixation of the fragments at the time of operation.

COMMENT

In a comparison of the results in the patients treated by internal fixation with those in patients treated by nonoperative measures, the mortality was no higher in the operative series. In hospitals where the nursing problem makes it difficult to give patients in body casts adequate care, the mortality would be much less in the patients treated by operation than in those treated by casts or in traction.

The patients treated by internal fixation are more comfortable. Adequate medical care, especially to prevent decubitus ulcers and postoperative pneumonia, is facilitated. The time in the hospital is reduced, which is a saving in hospital beds and lightens the financial strain on the patient and his family. Cleveland and others⁹ have shown that senile psychosis is far more frequent in patients treated in body casts than in the patients treated by operation. At the present time, it is our policy to treat all patients that are not moribund by open reduction and internal fixation as soon as they can be hydrated and their general medical condition evaluated. In our experience the general condition of the patient can rarely be improved by delaying surgical treatment more than twelve to twenty-four hours. The patients' general condition usually improves after the operation, as they can be moved often and with little pain.

9. Cleveland, M.; Bosworth, D. M., and Thompson, F. R.: Intertrochanteric Fractures of the Femur: A Survey of Treatment in Traction and by Internal Fixation, *J. Bone & Joint Surg.* **29**:1049 (Oct.) 1947.

Trochanteric fractures usually unite: consequently, they have not been given the consideration in medical literature that has been devoted to fractures of the neck of the femur. Avascular necrosis of the head of the femur, seen so often after fractures of the neck of the femur, is not seen after trochanteric fractures. The only exception to this rule was in 1 case of fracture of the base of the neck of the femur associated with a comminuted trochanteric fracture. In other respects, trochanteric fractures are more serious than neck fractures. In our series¹⁰ the average patient with a trochanteric fracture was older than the patients with fractures of the neck of the femur and the mortality has been about double. The operation required for internal fixation of a trochanteric fracture is more extensive than that for a fracture of the neck of the femur. We routinely give 500 cc. of whole blood at the time of operation. This is not necessary with fractures of the neck of the femur unless the general condition of the patient requires it.

The prognosis in type III subtrochanteric fractures is poorer than in the other three types. Coxa vara is more apt to occur. Nonunion, rare in trochanteric fractures, is most apt to be seen in this type. If the type III fractures are not well stabilized at the time of operation, medial migration of the distal fragment may occur. If this complication is likely, additional internal fixation is indicated.

SUMMARY

1. Three hundred cases of trochanteric fractures are reviewed.
2. There was a gross mortality rate of 18 per cent.
3. The fractures have been classified into four types and the prognosis given for each group.
4. The difficulties encountered in the subtrochanteric (type III) fractures are emphasized and a method to prevent medial migration of the distal fragment suggested.
5. Various forms of treatment are evaluated, with the conclusion that operative treatment and internal fixation is the treatment of choice.

DISCUSSION

DR. DON H. O'DONOGHUE, Oklahoma City: This is a pertinent subject for some of us "bone setters." As you are all well aware, in the last few years there has been a drastic change in treatment of a fracture of the neck of the femur to the point where I think it is completely accepted that if a fracture of the neck of the femur will not survive surgical repair it will not survive so-called conservative treatment.

I believe the treatment should not be called conservative or operative but should be called nonsurgical or surgical, because in the great majority of instances the surgical treatment is the conservative treatment.

10. Boyd, H. B., and George, I. L.: Fractures of Hip: Results Following Treatment, *J. A. M. A.* **137**:1196-1199 (July 31) 1948.

I have heard Dr. Boyd talk on this subject before, and I know he was handicapped somewhat this morning from the standpoint of time. I think we should enlarge a little not on the technical factors, because they are not particularly important, but on the problem as a whole. What are the alternatives in the treatment of an intertrochanteric fracture? As a rule the intertrochanteric fracture occurs in a slightly older age group than does a fracture of the neck of the femur. These persons are extremely poor risks, no matter what you do.

The so-called conservative or, as I prefer to call it, the nonsurgical method entails one of two or three things: First, do nothing to the leg. Second, put it in a cast with various forms of fixed traction. Third, put it in so-called movable traction with Kirschner wires and weights. Any of those methods entails a long period in bed. That time in bed may range anywhere from twelve to twenty-four weeks. If you put a person in that age bracket to bed for that length of time you will make an invalid of him.

Dr. Boyd's figures on mortality are entirely misleading if you consider a patient's useful life rather than the fact that he is alive and breathing. Old persons put to bed for many weeks, or kept in the hospital for many weeks, become disoriented and mentally unbalanced; they have a great deal of difficulty in ever regaining that spark which keeps them alive and in active health.

I would like to second Dr. Boyd's comment that if the patient is not moribund on admission surgical treatment should be strongly considered. Almost uniformly we regret later not operating on patients because they are bad risks. If they are going to be operated on they should be operated on soon. That does not mean particularly as an emergency. You can take twelve, twenty-four or thirty-six hours to prepare them, if you wish. After that length of time you will lose ground unless there is some specific problem you can remedy.

Too often the medical consultant will say: "Let me build him up and get him in better shape." The result is that the patient gets in worse shape. I think that in another five or ten years the surgical treatment for intertrochanteric fractures will be just as much accepted as is the surgical treatment now for fractured neck of the femur.

DR. JAMES J. CALLAHAN, Oak Park, Ill.: About seven years ago we collected 100 cases of intertrochanteric fracture picked at random. Most of those cases were of two to ten years' duration. We were surprised at the end results. Naturally, in a county institution one cannot get the response of outpatients that one would like to have. We had an adequate response. In this number of cases we found that on return examination every patient had from $\frac{1}{2}$ to 2 inches (1.27 to 5.08 cm.) of shortening. When they left the hospital their legs were of equal length. We had 1 case of nonunion.

The peculiar complaint of all those patients was not pain in the hip but pain in the back because of the shortening and the fact that the back could not accommodate this. The arthritic changes were present in the back.

These patients were all treated conservatively, or nonsurgically if you wish. It is our belief that patients with intertrochanteric fractures which are not comminuted, or, as in Dr. Boyd's classification, with type I fractures, should be operated on. We do not operate on comminuted fractures. I realize that this is a departure, but when you try to operate on these patients you have an eggshell to put your plate on, or screws or whatever type of internal fixation you wish to use, and frequently you will find that after putting in this internal fixation, if it is not protected adequately, it will break through or break off.

DR. KELLOGG SPEED, Chicago: I am a great admirer of Dr. Boyd, his clear thinking and the excellent way in which he expresses his thoughts. Also, as you all know, he works with Speed.

In the matter of the care of these fractures, in 1921 I reported a series of 120 cases without operative correction. Since then I have practically never used operative fixation for this type of fracture, for some of the reasons which Dr. Callahan has already stated or which have entered into the discussion. These persons are old, and their bones are soft, and the trauma of the injury, which does not so seriously affect the young active person, leads to serious fracture.

(Slide) The mechanism of the injury is a fall on the side and not a preliminary fracture or trip, as in fractures of the neck of the femur. There is a massive force applied on the thigh, with the body weight acting as the other factor to separate the intertrochanteric part of the femur.

(Slide) This opens up a large part of the femur, composed of porous or cancellous bone which has perhaps the best blood supply of any part of the whole femur; so you may expect, as already has been said, that a bony union will develop.

(Slide) The different types (and these are illustrated by me in 1921) shown are the same as those that Dr. Boyd has mentioned to you, without any attempt at too rigid classification. I do not believe you can put them all in closely bound bundles, but the slide shows the different types as then described.

(Slide) The worst types are these comminuted ones or the impacted ones, in which the sharp angle of the head fragment is shoved down into the cancellous bone of the trochanteric fragment.

(Slide) The most difficult ones are those in which there is gross overriding or shortening, generally in the neglected type.

For nonoperative treatment we use the Russell traction. This will pull down most of the fractures within twenty-four hours, especially if you put a box under the foot on the well side, a padded box such as a starch box, so that the patient can use his good leg for counterpressure. The Russell traction inevitably pulls down and abducts, and in most cases within twenty-four hours there is a reduction.

Eight weeks is all that any patient requires in bed, regardless of age. I disagree with Dr. O'Donoghue that some need twelve or twenty weeks. Eight weeks is all they need, and then they can be put in a chair and their progress stimulated in the ordinary way.

It seems to me that with the thinness of the outer wall of the femur and the dangers of operation, not in the hands of Dr. Boyd or of the men in the Campbell Clinic or of other surgeons present here but in the hands of the average physician, the implanting of complicated angle irons is far too great for them to attempt.

DR. F. WALTER CARRUTHERS, Little Rock, Ark.: I have had many opportunities in the past to see and observe intertrochanteric fractures. I feel that it is timely to emphasize, particularly to the patient, the difference between intertrochanteric fractures and capital fractures of the neck of the femur. No doubt many of you have the same experience as I with the referral of such a case. The attending physician many times says: "I am sending you a patient with fracture of the hip." They use this term when in reality it is an intertrochanteric fracture.

In my personal interviews with my patients who happened to be the victims of intertrochanteric fractures—usually seen in elderly women and occasionally in men—I refer to the intertrochanteric fracture as a fortunate fracture, in spite of the high mortality, as demonstrated by Dr. Boyd. It occurs in the older person. The patients themselves are interested in only one question: "Will my fracture unite, and will I be able to walk again?" In my answer, based on statistics, I assume full confidence of a union. This, I think, is a good answer psychologically.

Obviously, if the patient dies as a result of the particular type of fracture, nothing can be done. On the other hand, the assurance of the patient who survives that he can expect a union and be able to walk is a paramount conclusion in the case after all.

At this time I can recall nonunion in only one intertrochanteric fracture and that was a fracture involving pathologic changes in the bone. One should bear in mind from the beginning that one is dealing with an intertrochanteric fracture which is in reality a fracture of the shaft of the femur involving the trochanteric region. This certainly places it in a specific anatomic category, in direct contrast to a capital fracture only about 1 inch (2.5 cm.) away.

There are, obviously, many types. The subtrochanteric types are the ones that really give us trouble, particularly with reference to postangulation.

DR. R. C. WEBB, Minneapolis: It has been suggested that weight bearing might be started in some cases of intertrochanteric fractures of the femur after eight weeks. In this connection I should like to mention an experience with a 45 year old man who had an average type of intertrochanteric fracture of the left femur in good position except for marked coxa vara. The fracture was seven weeks old when I first saw him, and I applied 50 pounds (22.7 Kg.) of skeletal traction through the lower end of the femur for forty-eight hours. Although I nearly dislocated the hip downward, I found that the callus was still soft enough to permit restoration of the normal angulation to overcome the coxa vara.

DR. JAMES JACKSON, Madison, Wis.: It gives me great pleasure to be here and to see that there are many orthopedic surgeons who have been converted to the method of open reduction and internal splinting of fractures.

Thirty-six years ago, in 1912, I did my first open reduction at a time when this type of procedure was openly criticized by most surgeons. In fact, I appeared before a meeting of the Railway Surgeons in Chicago a few years ago, where I showed slides from some 200 cases of open reduction of fractures of the long bones. In a discussion of my paper a prominent Chicago surgeon said he did not believe a single word the author said.

Today, when men are doing such brilliant work with open reduction and internal splinting of fractures, I feel justified in having once been a bone surgeon.

DR. HAROLD B. BOYD, Memphis, Tenn.: The discussion has been interesting and instructive. I wish to thank all the discussers. Some of the points discussed are included in the written paper which time did not permit reading.

Dr. Speed, whom I admire very much, has brought to our attention the treatment of these patients by traction. There is no question that good end results can be obtained in trochanteric fractures by conservative treatment. The principal reasons for operating on these patients are medical and not surgical. Every surgeon cannot treat trochanteric fractures the same, but we feel that in the majority of patients open reduction and internal fixation is a good method. The patients are more comfortable; they are in the hospital on an average of two to three weeks, which is an economic saving to the family and also makes more hospital beds available. In hospitals with adequate nursing care the mortality is about the same in the nonoperative group as in the operative group. In hospitals without adequate nursing care for patients in body casts or in traction, the mortality is much less in the patients treated with internal fixation.

Surgical thinking should not be kept in logic-tight compartments. Patients should be treated in the manner which is best suited to the individual patient, the surgeon and the equipment with which he must work. We do not think that all trochanteric fractures should be treated with internal fixation in all circumstances and by all surgeons. But for our patients we feel that internal fixation in the vast majority is the method of choice.

HEMIPELVECTOMY FOR MALIGNANT TUMORS OF THE BONY PELVIS AND UPPER PART OF THE THIGH

ROBERT A. WISE, M.D.

PORTLAND, ORE.

HEMIPELVECTOMY is the term most frequently applied to the operative procedure in which the entire lower extremity with the adjacent innominate bone is removed through the sacroiliac and pubic joints. Other descriptive, though more cumbersome, designations for this operation are interinnomino-abdominal amputation,¹ interpelvi-abdominal disarticulation,² sacroiliac disarticulation³ and disarticulation of the innominate bone.⁴

Hemipelvectomy offers the best method for eradication of primary, radioresistant malignant tumors of the ilium, ischium and pubis. It is also indicated for malignant tumors of the upper part of the thigh which encroach on or involve the innominate bone or pelvic parietes. A compromise with good surgical treatment of tumors has been made frequently in dealing with malignant growths of the upper part of the thigh by performing a disarticulation of the hip joint, a procedure in which it is often impossible to remove the tumor widely.

While only on hundred and thirty-eight hemipelvectomies had been reported in the literature to 1946, with a high operative mortality,

From the Surgical Service of the United States Veterans Hospital.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 4, 1948.

1. (a) Ghormley, R. K.; Henderson, M. S., and Lipscomb, P. R.: Interinnomino-Abdominal Amputation for Chondrosarcoma and Extensive Chondroma: Report of Two Cases, *Proc. Staff Meet., Mayo Clin.* **19**:193-199, 1944. (b) Gordon-Taylor, G.: A Further Review of the Interinnomino-Abdominal Operations: Eleven Personal Cases, *Brit. J. Surg.* **27**:643-650, 1940. (c) Morton, J. J.: Interinnomino-Abdominal (Hindquarter) Amputation, *Ann. Surg.* **115**:628-646, 1942.

2. Pringle, J. H.: The Interpelvi-Abdominal Amputation: Notes on Two Cases, *Brit. J. Surg.* **4**:283-296, 1916.

3. Pack, G. T., and Ehrlich, H. E.: Exarticulation of the Lower Extremities for Malignant Tumors: Hip Joint Disarticulation (With and Without Deep Iliac Dissection) and Sarco-Iliac Disarticulation (Hemipelvectomy), *Ann. Surg.* **123**:965, 1946; **124**:1, 1946.

4. Sugarbaker, E. D., and Ackerman, L. V.: Disarticulation of the Innominate Bone for Malignant Tumors of the Pelvic Parietes and Upper Thigh, *Surg., Gynec. & Obst.* **81**:36-52, 1945.

recently the procedure has been performed more frequently and more safely. Pack³ reported six such operations without mortality, and my colleagues and I have had a similar experience with five.

TECHNIC

The technic of the operation originally described by Pringle² has been standardized by Pack.³ A useful addition to this technic has been the temporary control of the common iliac artery.³ The incision is made from the symphysis pubis, following the inguinal ligament to the anterior-superior spine of the ilium. It continues along the crest of the ilium and then directly downward just posterior to the greater trochanter, across the gluteal fold and upward to the point of origin. The attachments of the rectus abdominis muscle and the inguinal ligament to the pubis and iliac spine are divided. The inferior epigastric vessels are ligated and divided and the spermatic cord retracted. The peritoneum and the



Fig. 1.—Gross specimen, showing rhabdomyosarcoma of upper part of the thigh in case 1.

bladder are retracted medially, exposing the iliac fossa. The common iliac, external iliac and hypogastric arteries are exposed, and a controlling tape is placed around the common iliac artery, the occlusion of this artery being maintained throughout the remainder of the operation. The external iliac artery and vein are transfixed, doubly ligated and divided. The muscles attached to the crest of the ilium are now divided. The symphysis pubis is then separated with an osteotome. The psoas muscle is divided as high as possible, the femoral nerve sectioned and the sacroiliac joint exposed. This joint is divided. It is almost always possible to divide the superior gluteal and obturator vessels and nerves during the anterior dissection.

The patient is now turned on the uninvolved side, and the posterior skin flap is developed back to the sacrum. The gluteus maximus muscle

attachment to the sacrum is divided and the muscle sectioned. The sciatic nerve is cut across, as are the piriformis and levator ani muscles. After division of the sacrotuberous, sacrospinous and sacroiliac ligaments, the extremity is removed. The controlling tape of the common iliac artery is removed and the skin flaps approximated with through and through interrupted sutures of silk.

REPORTS OF CASES

CASE 1.—*Hemipelvectomy for rhabdomyosarcoma of the thigh, extending to the pubic ramus.*

H. R., a white man aged 31, was admitted to the Veterans Hospital, Portland, Ore., on July 9, 1948, complaining of a tumor of the left thigh of two and a half



Fig. 2.—Postoperative photograph of wound in case 1.

years' duration. The patient was injured in 1945 at Pearl Harbor by an explosion, which resulted in the development of a large hematoma on the posterior aspect of the left thigh. The hematoma gradually subsided, but six months later a hard, movable mass, 5 cm. in diameter, was noted on the medial aspect of the thigh. This mass gradually developed in size up to the time of his admission to the hospital. Examination revealed a huge, hard, tender mass covering the entire posterior and medial aspects of the left thigh, extending from the lower third of the thigh up to the pelvis. A roentgenogram of the chest was normal. A biopsy of the mass was performed on July 13, 1948. The diagnosis was fibrosarcoma.

Operative Procedure (July 21, 1948).—Hemipelvectomy was performed on the left side.

The convalescence was entirely uneventful. Constant gastric suction was maintained for four days, and a Foley catheter was left in the bladder for five days. There was no abdominal distention or urinary retention after removal of the tubes. There was primary healing of the wound.

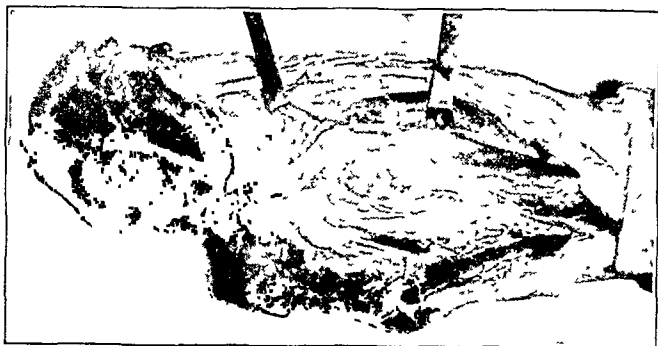


Fig. 3.—Gross specimen, showing fibrosarcoma of the upper part of the thigh in case 2.

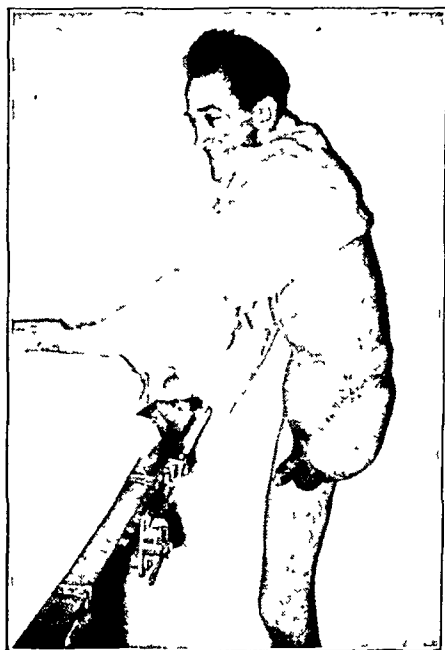


Fig. 4.—Photograph of wound twenty-one days after operation in case 2.

Pathologic Changes.—The specimen consisted of the left leg with the innominate bone (fig. 1). There was a hard, ovoid tumor mass, measuring 25 by 13 by 15 cm., occupying the posterior and medial aspects of the thigh, extending from the popliteal space to the inferior ramus of the left pubic bone. Microscopic sections revealed a varied picture. Those from the periphery of the mass showed the cells to be small and relatively uniform. The nuclei were rounded or oval, with fibrillary processes. There was evidence of invasion of the striate muscle. A

section from a deeper portion of the tumor revealed a markedly different picture. Here the tumor cells varied greatly in size and shape; some were tadpole shaped and others considerably elongated. Many of the cells had the appearance of striate muscle, and longitudinal and cross striations were clearly observed. The nuclei varied appreciably in size, shape and staining quality, and mitotic figures were occasionally observed. Various lymph nodes examined failed to reveal any evidence of tumor infiltration. The diagnosis was rhabdomyosarcoma of the left thigh.

Follow-up examination in November 1948 revealed a well healed, painless stump (fig. 2). Roentgenograms of the chest revealed no evidence of metastasis. Urinary and bowel control were normal.

CASE 2.—Hemipelvectomy for fibrosarcoma of the thigh.

J. W., a white man aged 60, was admitted to the Veterans Hospital, Portland, Ore., on Oct. 28, 1948, because of a painful mass in the upper aspect of the left thigh of two months' duration. Examination on admission revealed a firm, fixed mass in the anterior aspect of the upper third of the left thigh, 10 cm. in diameter. The mass extended to the inguinal ligament. Biopsy of the tumor revealed a fibrosarcoma.

Results of Hemipelvectomy in 5 cases

Patient	Age	Diagnosis	Operation	Result
J. W.....	20	Osteochondrosarcoma, ilium	March 1947	Died 13 mo. postoperatively from pulmonary metastasis
R. T.....	38	Osteochondrosarcoma, ilium	July 1947	Well 18 mo. postoperatively; no metastasis
L. G.....	32	Osteogenic sarcoma, femur	November 1947	Well 13 mo. postoperatively; no metastasis
H. R.....	31	Rhabdomyosarcoma thigh	July 1948	Well 6 mo. postoperatively; no metastasis
J. W.....	60	Fibrosarcoma, thigh	November 1948	Well 1 mo. postoperatively; no metastasis

*Operative Procedure (Nov. 3, 1948).—*Hemipelvectomy was performed on the left side.

The convalescence was complicated by considerable serosanguineous discharge from the wound, which, however, healed firmly without infection (fig. 3). The patient is now ambulatory on crutches.

Pathologic Changes.—The specimen consisted of the left leg with the innominate bone (fig. 4). There was a hard, tumor mass, measuring 10.5 by 9.5 by 7 cm. occupying the anterior surface of the upper third of the thigh. The tumor had grown into the lumen of the common femoral vein, completely occluding it. Microscopic sections revealed variations in the appearance of the cells from different areas of the growth. In one part the cells tended to grow in whirls and bands and had the appearance of smooth muscle; in another section they were more widely separated. The nuclei were generally small, but frequently they were large and irregular. Atypical mitotic figures were observed occasionally. There was no evidence of cross striations, and spider cells were not observed. The lymph nodes failed to reveal tumor. The diagnosis was fibrosarcoma of the left thigh, with extension into the femoral vein.

Hemipelvectomy has been performed in 5 cases, including the 2 cases described, at the Veterans Hospital, Portland, Ore., since 1947 for primary malignant tumors of the innominate bone or upper part of the thigh. I have previously reported the first 3 cases.³

PROSTHESIS

A helpful prosthetic device has been constructed at the Portland Veterans Hospital for patients who have undergone hemipelvectomy. Ghormley^{1a} reported the use of a belt for support of the pelvic contents.

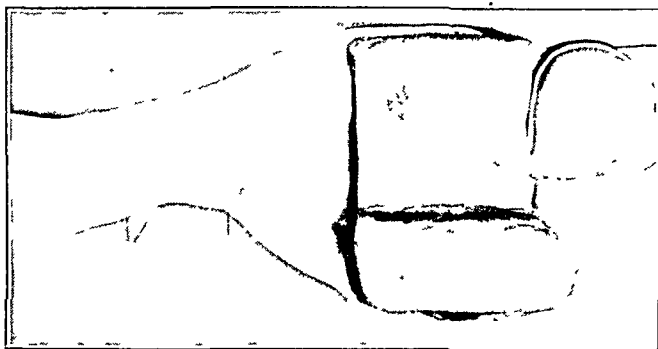


Fig. 5.—Photograph of prosthesis.

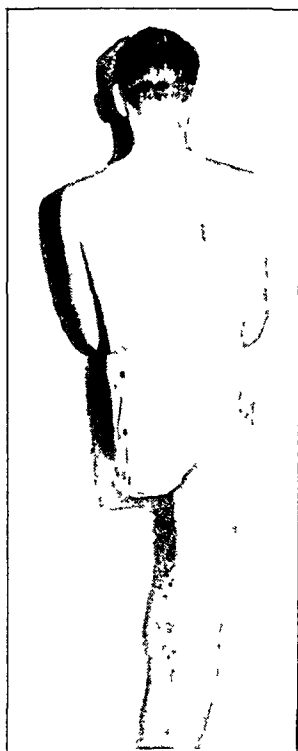


Fig. 6.—Photograph of patient wearing prosthesis (case 1).

The prosthesis referred to consists of a canvas belt in which three leather-covered pads are incorporated, these pads serving as a support to the abdominal wall and taking the place of the removed buttock

(figs. 5 and 6). This prosthesis makes it possible for the patient to sit upright with comfort, with weight equally divided on the remaining buttock and the prosthetic pad.

SUMMARY

1. Experience with hemipelvectomy in 5 patients with primary malignant tumors of the innominate bone or upper part of the thigh is outlined.

2. A useful prosthetic device to replace the removed buttock is reported.

DISCUSSION

DR. KELLOGG SPEED, Chicago: This term "hemipelvectomy" I coined seventeen years ago, when I reported 2 cases before the Society. At that time there was no prosthetic support available for the care of such patients, but with the advance of the knowledge obtained in the war we are now able to help them, and, as Dr. Wise has shown you, we are now able to let them walk and thus overcome much of their disability.

This is a remarkable series of cases. Since I first made my report, I have had several chances to operate on patients, but I have never again been able to get the patient's permission. I daresay there are other men here who have done the operation.

The English surgeons laugh at the term "hemipelvectomy," and Pringle and others use the term "interileoabdominal amputation." That is a mouthful, but perhaps you prefer it.

DR. W. E. LEIGHTON, St. Louis: Of the first 10 cases reported in the United States, four members of the Western Surgical Association accounted for 7 of them. In 3 other cases operation was performed by Babcock, of Philadelphia, and Keene, of Philadelphia.

In regard to the reason why so few of these operations have been done, when a French surgeon was called on to perform one, he stated that he had never done the operation, he had never seen it performed and probably none of his confreres could give him very much information on the procedure.

That was my start in this amputation. I had never seen it done, and all I knew about it was what I had read of the few cases reported. I performed one and got a successful result; the man is still alive fourteen years later and walks around on crutches because we have never had anyone come to us who would fit a prosthesis that would be of use.

The term "hemipelvectomy" I have abbreviated and have called it the "hind-quarter amputation," because it looks like removing the hindquarter of a beef. As in all operations for malignant growth, you cannot get much assurance of a cure by selecting a piece of bone to remove. The best cure for a malignant growth is a wide excision and amputation through the bone above. When you have a sarcoma of the pelvic bone, the only thing that promises any success is entire removal of the bone involved.

May I quote from a paper I wrote concerning the frequency of these tumors? "In Geschickter and Copeland's book on tumors, published in 1931, they collected 155 cases of sarcoma. In 86 of these cases the tumor was primary in the innominate bone; seven patients died following palliative treatment, such as excision or radiation. Only one was living at the end of twenty months, but the tumor was

still active. Among 88 cases of osteosarcoma collected by Geschickter, he found only one case in which the growth arose in the pelvis, and this patient did not survive palliative treatment. Upon analyzing the 108 cases that I collected in 1940, the operation was performed for sarcoma 73 times, and in 27 cases the disease was primary in the os pelvis; 13 patients recovered and lived from two months to five years or more; 14 patients died, most of them within a few hours, so the mortality rate of all the collected cases at that time was 51 per cent."

However, as Dr. Wise has shown, with careful technic the operation is easily done, and a good exposure is made by the procedure described. It is possible to take out the entire affected bone. A Spanish surgeon has given it the name, "interabdomino sacro-pubic disarticulation."

An opportunity should be given to the patient to recover, and he may recover, as shown by the number of cases reported and by my own personal experience with the first operation of this type I ever performed.

DR. MARTIN NORDLAND, Minneapolis: I had a case within the last year with a questionable diagnosis of a malignant tumor of the bony pelvis. I am not an orthopedist and have never been confronted with this problem before. I should like to have Dr. Wise tell me how to determine in an early case, or in one with a questionable diagnosis, what evidence is needed to make the decision to operate.

A healthy-appearing 31 year old man came to me with a severe pain in his left hip. The pain was of recent origin and could be relieved only with morphine. There was no history of trauma. There was nothing of significance revealed by the general physical examination save that a mass could be palpated in the left groin. The routine tests of the urine and blood, including a Wassermann test, gave a negative reaction. The roentgenographic studies of the pelvis, lumbar and sacral regions of the spine, left hip and upper portion of the left femur showed a lesion of the left ilium. The roentgenologist could not exclude a malignant growth. We felt that we were dealing with an osteomyelitic process. We hesitated to do a biopsy. We treated the patient with penicillin, and he made a slow but complete recovery.

DR. ROBERT A. WISE, Portland, Ore.: I wish to thank Dr. Speed, Dr. Leighton and Dr. Nordland for their discussion. In answer to Dr. Nordland, there is one fixed rule which I think we should always follow before contemplating a procedure as dismantling as this one, and that is that we should never, in any circumstances, perform this operation unless the diagnosis is proved by biopsy. In the case you mentioned, if there were any question of the lesion being a primary tumor in the region of the pelvis or the greater trochanter, I believe that an exploration, a biopsy and a paraffin section would be indicated. The pathologist's report should then be awaited.

I believe that the time has come when we should no longer consider this operation as a tremendous one or one to be looked on as a rarity or an oddity. The procedure should be a part of every surgeon's armamentarium. It is a mistake, I am sure, to condemn some of these patients to palliative radiation therapy when it is known that little can be achieved with that method of treatment or to subject the patient to disarticulation of the hip joint because that procedure is better known and either not remove the tumor widely or actually leave some of it.

Earlier we did three disarticulations of the hip joint for tumors of the upper part of the thigh and actually found that the postoperative course was longer, in 2 cases more severe, and the healing of the wound delayed for many months for the reason that with these tumors it is necessary to sacrifice the rectus femoris and the sartorius muscles, structures which are usually used to fill the acetabulum. When that cannot be achieved delayed healing is almost inevitable.

CARCINOMA OF THE THYROID GLAND

ARNOLD S. JACKSON, M.D.

MADISON, WIS.

FOR years it was traditional never to give iodine to a patient having exophthalmic goiter and always to drain in a case of ruptured appendicitis with peritonitis. Universally, patients were confined to their beds for one or more weeks after operation. Spinal anesthesia was considered a dangerous anesthetic, to be used only in rare instances. Thousands of yards of gauze and adhesive tape were piled on the patients' abdominal incisions in the hope of protecting the incision from contamination and of strengthening the wound. My entire thirteen minutes could be devoted to a discussion of traditional ideas in surgery whose abandonment years ago might have saved thousands of lives which were unnecessarily sacrificed to the god of tradition. Tradition is the enemy of progress. So I believe that we have come to a new era in medical writing. In this busy world we have little time to read long medical articles written in traditional style. Instead we read the summary, and if it interests us, we may turn back and review a few paragraphs and occasionally the entire article. I have been asked to present the subject of carcinoma of the thyroid in thirteen minutes. By streamlining this article, by first presenting my conclusions after the manner of the press and by amplifying the most important of these facts in the remaining minutes I hope to set a style in medical writing that will encourage others to abandon the traditional form of the past.

A study of 40 cases of carcinoma of the thyroid gland revealed these facts:

1. In 90 per cent the carcinoma arose in a preexisting adenoma.
2. In 18 the condition was undiagnosed prior to operation.
3. Forty per cent of the tumors occurred in males.
4. The relationship of hyperthyroidism was inconsequential.
5. Eleven of the 40 patients were inoperable when examined.
6. Six patients remain well five years after operation.
7. In 1 patient a recurrence developed twenty-four years after thyroidectomy.
8. The incidence of carcinoma in this series was 5 per cent.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 4, 1948.



Fig. 1.—Photomicrograph of a well differentiated papillary adenocarcinoma. There is slight cellular and nuclear pleomorphism and slight loss of cellular polarity. There is also invasion of the stroma by epithelial elements. Hematoxylin and eosin stain; $\times 180$.



Fig. 2.—Photomicrograph of a well differentiated papillary adenocarcinoma of the left lobe of the thyroid. This is one of the less well differentiated areas. Note the large vascular space in the upper portion of the field which contains an embolus composed of tumor cells. Hematoxylin and Eosin stain; $\times 80$.



Fig. 3.—Photomicrograph of tumor of the midportion of the right tibia. It is composed of epithelial type cells having a glandular and papillary arrangement. Some of the acini contained homogenous deeply staining eosinophilic material resembling colloid. This suggested that the metastatic lesion was from a thyroid carcinoma. Hematoxylin and eosin stain; $\times 175$.



Fig. 4.—Photomicrograph of an adenomatous focus in the thyroid from the patient in the previous figure, showing considerable distortion of glands and isolated epithelial cells in the stroma. Other criteria of neoplasia are absent. Hematoxylin and eosin stain; $\times 190$.

These conclusions are essentially in accord with the findings of other authors. Over one hundred articles dealing with this subject appear in the literature. Considerable difference of opinion has occurred concerning the pathologic classification and only serves to confuse the reader. The following classification is offered.

1. Papillary adenocarcinoma. This comprises about 33 per cent of the tumors, occurs at all ages but more frequently in youth and has the most favorable prognosis. The so-called aberrant thyroids, once thought to be congenital rests giving rise to malignant processes, are metastatic lesions of this type involving the adjacent cervical glands. Their complete removal, followed by a total excision of the thyroid lobe on the same side and a subtotal excision of the remaining lobes, offers a favorable prognosis.



Fig. 5.—Patient with malignant degeneration of adenomatous goiter, the source of a metastatic bone tumor in the tibia seen in figures 3 and 4.

2. Carcinoma arising in a preexisting adenomatous goiter. This comprises about one third of the tumors. If it is removed early, before the lesion has invaded the blood stream, the outlook is favorable. This type is frequently not recognized prior to pathologic examination.

3. Diffuse adenocarcinoma. This comprises most of the remaining growths. It is highly malignant and rapidly fatal.

4. The sarcomas and epithelial types. These are rarely seen, although the former occurred in 3 cases in this series.

The symptoms of a malignant growth of the thyroid unfortunately usually indicate that surgical treatment has been too long delayed and that only palliative roentgen therapy remains. A history of recent rapid growth of a goiter, dyspnea, aphonia and a fixed hard mass prognosticate death in most instances.

One other controversial subject appears in the literature. Pember-ton and others have reported an incidence of cancer of 4 per cent in

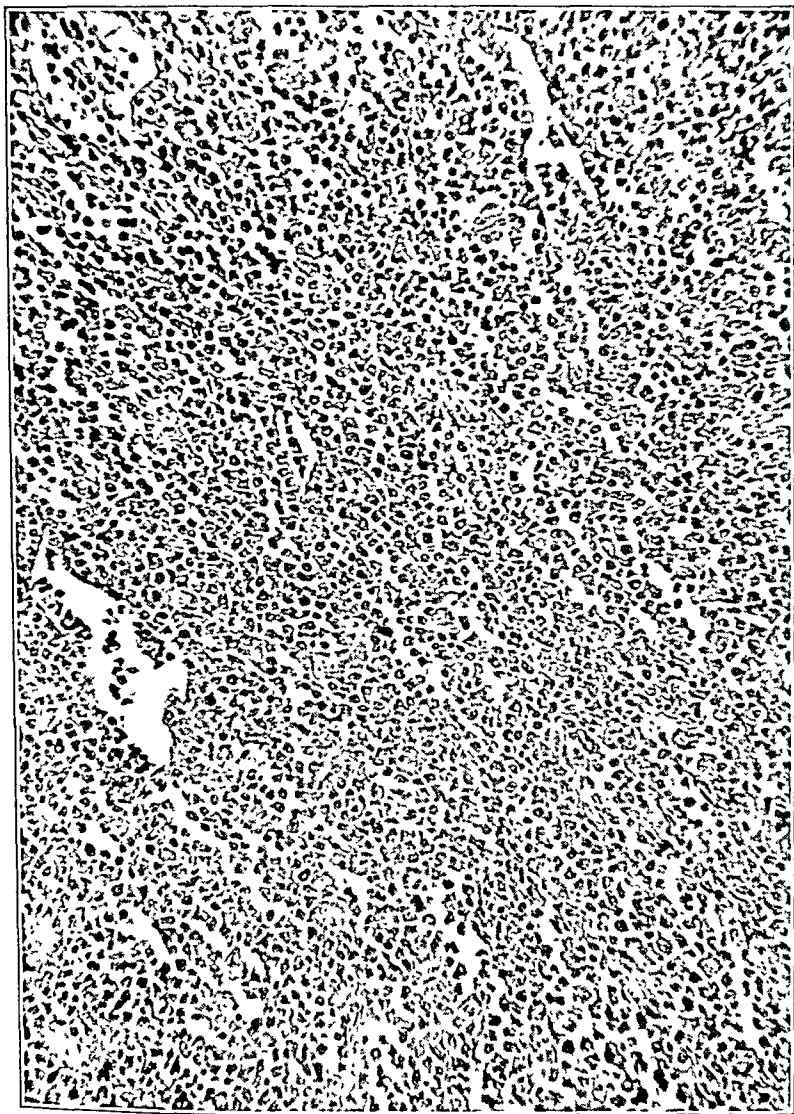


Fig. 6.—Photomicrograph of a reticulum cell sarcoma, clinically primary in the thyroid. Note the uniform small cells which comprise the tumor. Special stains show considerable reticulum intimately associated with the tumor cells. Hematoxylin and eosin stain; $\times 200$.

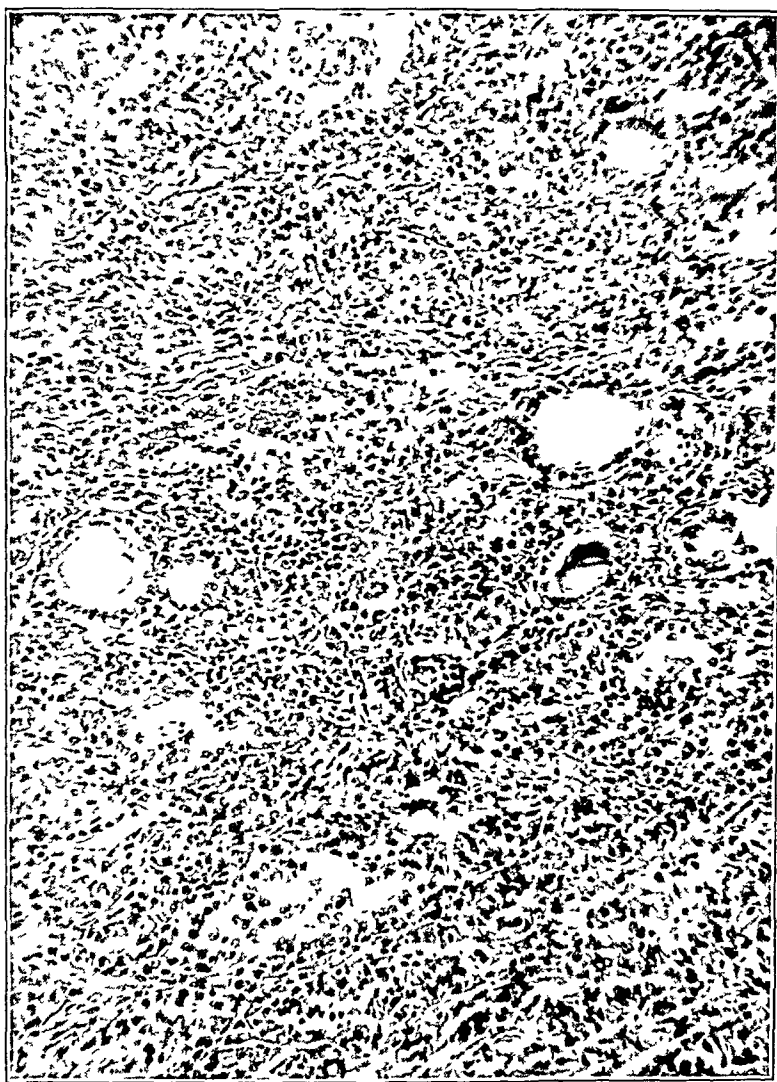


Fig. 7.—Photomicrograph of a representative portion of a section from a case of chronic thyroiditis which was misdiagnosed as a thyroid carcinoma in 1943. Note the acinous disarray. Many of the acini do not contain colloid and are lined by hyperplastic epithelium. Many of the small cells in the interglandular stroma are plasma cells and small lymphocytes. Hematoxylin and eosin stain; $\times 200$.

cases of adenomatous goiter, whereas in 1945 Warren Cole started much discussion by reporting an incidence of 17.1 per cent in a series of 193 cases of nodular goiter, 11 per cent in 100 cases of the multinodular type and 24 per cent in cases of the solitary form. My own experience has recently shown an increase from 4 to 5 per cent, and I believe that if all adenomas that were seen were operated on this figure would possibly rise to 7 per cent.



Fig. 8.—This patient's condition was incorrectly diagnosed as a malignant disease of the thyroid by the pathologist in 1943. Subsequent study by other pathologists revealed chronic thyroiditis (see fig. 7).

Radioactive iodine has aided in the detection of carcinoma of the thyroid but has so far failed to effect a cure since it attacks some but not all of the malignant cells. Prevention, early operation, roentgen rays and radium are still the most effective means of treatment.

Carcinoma of the thyroid is the most easily preventable type of malignant growth. Since it arises in a preexisting adenoma in 9 of

every 10 cases, it could be eliminated in 90 per cent if all adenomas were removed when found. Most adenomatous goiters could be prevented by the use of iodine in the prevention of colloid goiter.

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DISCUSSION

DR. MARTIN NORDLAND, Minneapolis: I believe that we have no trouble in convincing surgeons that adenomas should be removed for many reasons, including prophylaxis against a malignant process. I have noticed, as have you, that many of the medical profession, including good internists, are not so easily convinced. To some patients it is always a "lump in the neck." It is strange that so many internists and others use the basal metabolism rate as the criterion for surgical treatment. Dr. Jackson pointed out that they forget that hyperthyroidism itself is not necessarily the thing we have to worry about.

A simple definition of the word "goiter" years ago was "a change in the size or function of the thyroid gland." Hyperthyroidism so often is the main thought in the clinician's mind. In the absence of hyperthyroidism, he feels that surgical intervention is not warranted, and so the adenomas are forgotten. He apparently is guided by the old jingle, "Why bother the goiter until the goiter bothers you?" Since all malignant growths of the thyroid have their origin in a preexisting adenoma, any patient coming in with a "lump" in the thyroid gland should have the mass removed for this reason alone.

Unfortunately, the textbook description of malignant growths of the thyroid is the description of the far advanced malignant process. When the patient has pain and huskiness of voice, it is already far advanced and too late for successful surgical treatment. The time to attack it is when the patient has none of these symptoms. We remove goiters for cosmetic reasons, adenomas causing pressure symptoms and hyperthyroidism. Because it is a simple procedure now, with a mortality of less than 0.5 per cent, it should be recommended. As Dr. Jackson has pointed out, I believe that we should be more eager to remove these conspicuous and obvious tumors that seem not to trouble the patient.

DR. WARREN H. COLE, Chicago: Dr. Jackson has made many fine points about carcinoma of the thyroid and so concisely that I wish to reiterate a few of them: 1. Hyperthyroidism is inconsequential in carcinoma; 2. Too many patients with carcinoma of the thyroid arrive for surgical treatment in the inoperable state; in his series there were 27 per cent. 3. At least 95 per cent of aberrant thyroids are metastatic carcinoma of the thyroid. 4. If you wait until the symptoms of carcinoma are positive or diagnostic, you will be too late to attain a cure. 5. Radioactive iodine will not cure carcinoma of the thyroid.

I should like to add that carcinoma of the thyroid may be a geographic disease. For example, Dr. Slaughter, Dr. Rossiter and I have reported perhaps the highest incidence of carcinoma in all reports coming to my attention. I was talking to Martin Linden, and I apologize if he wanted to make the following comment himself. As you know, he is located in Salt Lake City, and in many years of surgical practice he has seen only 3 cases of carcinoma in hundreds and even thousands of cases of nodular goiter; furthermore, he told me that the 3 patients came from the Great Lakes area.

As Dr. Jackson said, we did report an incidence of carcinoma of 17 per cent in our cases of nodular nontoxic goiters, and I want to emphasize again that when talking about the incidence of carcinoma in all types of goiter if you add your cases of toxic diffuse goiter, it is like diluting your cases also with those of gall-bladder disease and appendicitis, because carcinoma is rarely encountered in toxic diffuse goiter.

In our first series, reported in 1944, we had 36 cases of carcinoma. The incidence was much higher in the solitary type than in the multinodular type. Thinking that such a high incidence may have been a coincidence, we summarized the figures again in the 1944 to 1948 period. Strange to say, the figure for carcinoma in nontoxic nodular goiter again was 17 per cent, with a total of 16 cases.

If any of you think we are being too liberal with a diagnosis of carcinoma of the thyroid, I have an answer for you. It is a sad one, I must say. In this last series we have followed all our patients closely. Sixteen patients in this series were followed. Eleven are dead already of metastasis; an additional one has metastasis and will not survive much longer. Surely that is not being too liberal in the diagnosis.

I wish to make another point on incidence. A pathologist in the east has suggested that we use autopsy figures as an index of the incidence of carcinoma of the thyroid. I have a good answer for that, too. In the series from 1944 to 1948 we had 16 patients with carcinoma of the thyroid, and our department of pathology encountered only 2 patients with carcinoma of the thyroid in that period—yet 11 of ours had already died. The 2 patients encountered by the department of pathology actually came from the previous series. Finally, I wish to emphasize that prophylaxis is an important feature, i. e., prophylactic removal of the nodules while they are still benign.

DR. ARNOLD S. JACKSON, Madison, Wis.: I thought that in the last twenty-five years I had studied nearly all phases of the thyroid, but I had not studied malignant growths, and what knowledge I have derived from it I credit largely to the inspiration of Warren Cole, who stirred me up on the subject.

I know that in my own work my incidence of malignant growths has increased since I have acquired an excellent pathologist at my right hand and since all specimens are most carefully studied. Often the pathologist now reports a small area of malignant change within a large adenoma.

I think that as we look more and more carefully for malignant growths we are going to find a higher percentage of them. I have not been able to get up to Warren's figures, but mine are increasing, and I believe that he deserves a great deal of the credit for arousing those of us who are interested in this matter.

THE ELDERLY PATIENT AS A SURGICAL RISK

An Analysis of Three Hundred and Twenty-Two Operations Performed on
Two Hundred and Forty-Four Patients Sixty Years of Age and Over

WILLARD H. PARSONS, M.D.

AND

W. K. PURKS, M.D.

VICKSBURG, MISS.

WITHIN the last two years any surgeon, merely by casual reading of the group of medical journals which a surgeon ordinarily reads, could have encountered six separate articles on peptic ulcer in the aged.¹ That chance occurrence would probably not have been duplicated ten years ago or even five years ago. It is related to such a statement as that made by Zeman and Davids,² who, writing in 1948, mentioned a woman who had been denied surgical relief for a cystocele in 1938, when she was 68, but was safely operated on for it in 1945, when she was 75. Medical literature of this sort seems to carry two implications. The first is the increase in the population of this country in persons in the upper age brackets. The second is the increasing importance of these persons to physicians in general and to surgeons in particular.

Since the turn of the century there has been a remarkable increase in life expectancy, which in the United States is now well over 60 years of age. The increases, however, as Groom³ pointed out, have not been uniformly distributed in all age groups. Between 1930 and 1940, for instance, while the whole population increased by only 7 per cent, there was an increase of 35 per cent in persons 65 to 74 years of age and an

From the departments of Surgery and Internal Medicine, Vicksburg Hospital.

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 4, 1948.

1. Boles, R. S., and Dunbar, W.: Peptic Ulcer in Old Age, *Geriatrics* **1**:217, 1946. Carnozzo, S. J.: Pyloric Obstruction Due to Stenosing Ulcer in the Aged, *J. Internat. Coll. Surgeons* **10**:304, 1947. Spang, K.: Gastroduodenal Ulcer in the Elderly, *Deutsche med. Wchnschr.* **72**:605, 1947; abstracted, *J. A. M. A.* **136**:903 (March 27) 1948. Kiefer, E. D., and McKell, D. M.: Peptic Ulcer in the Aged, *J. A. M. A.* **133**:1055 (April 12) 1947. Lasher, E. P.: The Course of Peptic Ulceration in Elderly Persons: A Clinical and Anatomic Study of One Hundred and Twenty-Two Cases, *Surgery* **23**:501, 1948. Rafsky, H. A.; Weingarten, M., and Krieger, C. I.: Onset of Peptic Ulcer in the Aged, *J. A. M. A.* **136**:739 (March 13) 1948.

2. Zeman, F. D., and Davids, A. M.: Gynecologic Surgery in the Elderly with Special Reference to Risks and Results, *Am. J. Obst. & Gynec.* **56**:440, 1948.

3. Groom, W. S.: Mortality and Life Expectancy in the United States Since 1900, *Geriatrics* **1**:384, 1946.

increase of 38 per cent in those over 75 years of age. On the basis of these gains, it has been estimated that by 1980, 40 per cent of the population will be above 45 years of age, while the group above 65 years of age will number 22,000,000 and will constitute 14 per cent of the total population.

Whether or not one accepts these figures absolutely, it is impossible not to admit the trend they represent. It is also not possible to ignore their surgical significance. At the present time, surgical treatment of persons over 60 years of age constitutes a relatively small proportion of surgical practice. In the not distant future it will constitute a much larger proportion, both because of the increase in the population and because older persons, generally speaking, require more surgical treatment—and often procedures of far greater magnitude—than do younger persons.

The general belief that elderly persons do not tolerate surgical intervention as well as younger persons is borne out statistically and is sound physiologically. The poorer results can be chiefly attributed to the fact that the older person does not possess the organic reserve which the younger patient possesses, nor does he possess what might best be described as the elasticity of youth. He lacks the ability to snap back. On the other hand, an unfortunately large proportion of the mortality of surgical procedures in elderly persons can be explained not by the fact that they are elderly but by the fact that their disease has been permitted to become irreversible. There were numerous instances of this sort in the series of surgical cases which we are reporting in this communication, and some of these, we regret to say, could be attributed to the bad advice which the patients had received earlier. They had been told that they were too old for surgical treatment. Another explanation of the advanced state of disease often observed in elderly persons is that disease processes, particularly when they are inflammatory, are likely to progress rapidly in elderly persons. Acute appendicitis is an outstanding example; the pathologic process in this disease is often more advanced at the end of twelve or twenty-four hours in the elderly persons than it is at the end of forty-eight to seventy-two hours in the younger person. Finally, disease processes are often advanced in elderly persons because the diagnosis has been missed. The explanation in some cases is the atypical character of surgical diseases in older persons—appendicitis is again a case in point—while other cases can be explained by the fact that the surgical disease has been masked by the clinical manifestations of a preexisting organic disease.

Age in combination with a surgical disease no longer warrants an attitude of fatalistic resignation. On the contrary, such a situation is a mandate to evaluate the status of the patient, to estimate the magnitude of his risk, and to put into play every possible technical advance and adjuvant measure to carry him safely through his ordeal.

There is also a philosophic aspect to surgical intervention in the aged. The senile person is frequently 70 or 80 years of age, it is true, but persons advanced in years are not necessarily senile. Sometimes they are far younger mentally, biologically and even physically than persons chronologically their juniors by many years. Many a man past 60 has ahead of him the most productive years of his life: Winston Churchill, to use but a single illustration, was well over this age when he lifted the hearts of the world in the first dark days of World War II. The mature judgment and wide experience of older men and women constitute a much needed bulwark of strength in present day society. The United States lost many of her young men in World War I and World War II,

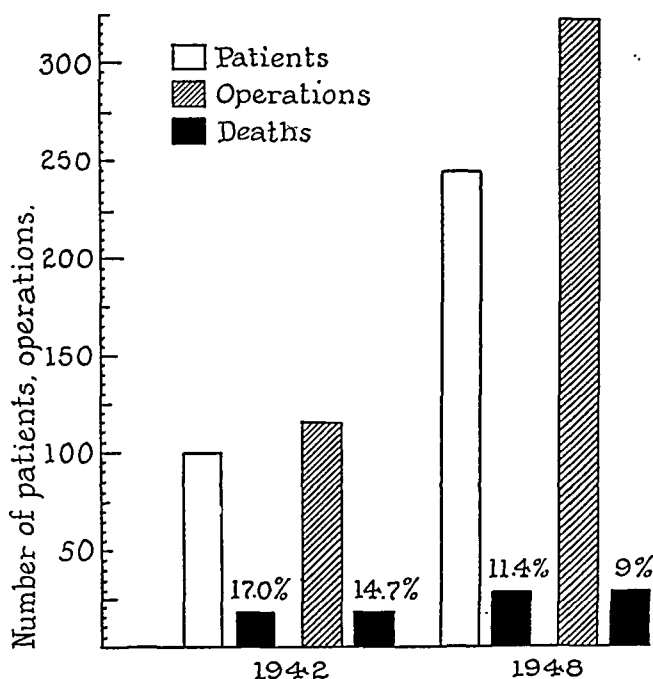


Fig. 1.—Comparative mortality in two series of operations on patients 60 years of age and over.

though we did not have, as did France and England, the experience of seeing the flower of our youth decimated twice in a generation. Now that we seem about ready to engage in another even more dreadful war, we cannot afford to overlook any means of conserving our population, regardless of its age.

FACTORS OF MORTALITY IN THE AGED

In 1942 we presented (fig. 1) from the Vicksburg Clinic an analysis of 115 major surgical procedures performed on 100 consecutive patients 60 years of age and over, with 17 deaths.⁴ This is a patient mortality of

4. Parsons, W. H., and Purks, W. K.: The Surgical Risk in Elderly Patients, *South. Surgeon* 11:525, 1942.

17 per cent and an operative mortality of 14.7 per cent. The present communication consists of an analysis of three hundred and twenty-two operations performed by a single surgeon (W. H. P.) on 244 patients in the same age group between 1942 and October 1, 1948. There were 29 deaths in the second group, a patient mortality of 11.4 per cent and a surgical mortality of 9 per cent.

Before passing to a discussion of special factors of mortality, it might be said that the decrease in the mortality in the second series of operations in the aged can be explained by a number of general factors.

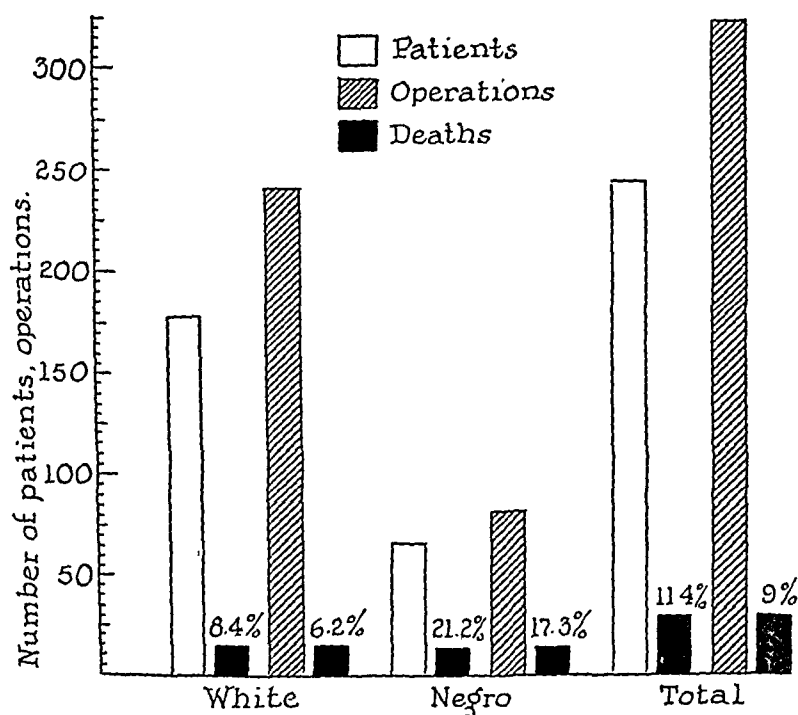


Fig. 2.—Racial mortality in 322 operations on 244 patients 60 years of age and over.

1. The increasing perfection of precision instruments and methods has made possible diagnoses which formerly could not have been established at all or could have been established only after a long delay. We trust, also, that our own diagnostic acumen has increased with the years. 2. Chemotherapy and antibiotic therapy have made enormous advances in the interim between these communications. Many patients in the earlier group were not treated with the sulfonamide drugs, the use of which was just becoming well stabilized at the time the study ended. In the second series, penicillin and streptomycin, which either did not exist or were not generally available for patients in the first series, unquestionably contributed to the lowering of the mortality. 3. The

chief reason for the decline in the mortality in the second series is our own increased awareness of the problems of surgical intervention in the aged, although, paradoxically, as time has passed we have found ourselves undertaking operations in this age group which a decade ago we would not even have considered.

At that, however, the mortality is higher for patients in the upper age brackets at the Vicksburg Hospital than is the over-all surgical mortality in this institution (1.08 per cent).

A mortality of 11.4 per cent per patient and 9 per cent per operation at first glance seems to warrant pessimism. When the figures are broken down, however, and are examined from various standpoints, certain apparently valid reasons for a more hopeful viewpoint emerge.

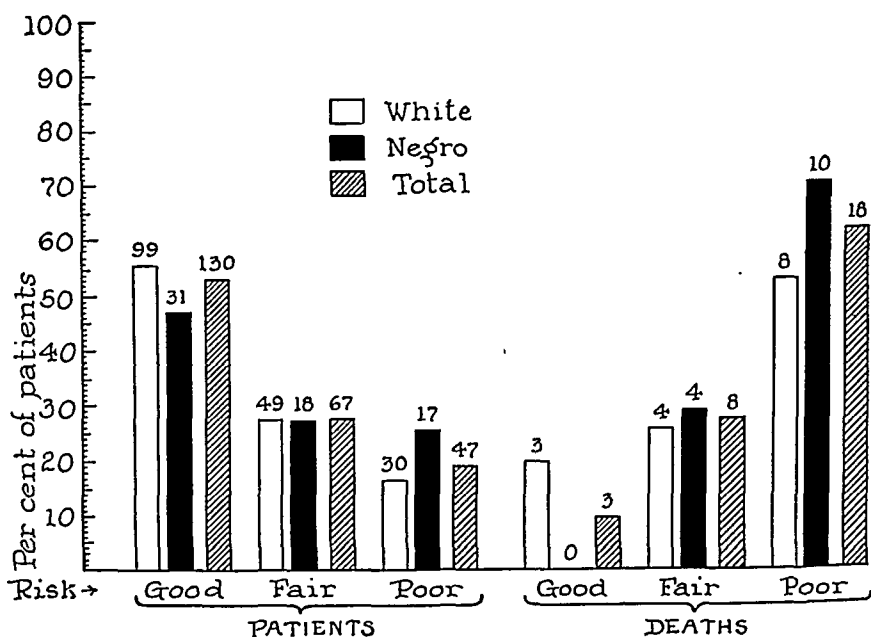


Fig. 3.—Proportionate distribution of mortality according to surgical risk.

RACE

First of all, like all surgeons in Southern hospitals, we must consider our mortality from the standpoint of race. There were 15 deaths in the 178 white patients in the series, 8.4 per cent, and 14 in the 66 Negro patients, 21.2 per cent (fig. 2). From the standpoint of separate procedures, there were 81 operations on the 66 Negro patients, the 14 deaths in this group giving a mortality of 17.3 per cent, and 241 operations on the 178 white patients, the 15 deaths in this group giving a mortality of 6.2 per cent.

When the cases are examined from the standpoint of the surgical risk they presented, the explanation of this wide discrepancy is immediately

apparent (fig. 3). The proportion of good risks in the Negro group was 47 per cent, as compared with the white proportion of 56 per cent. The proportion of fair risks in each group was approximately the same. The proportion of poor risks, however, was widely different, 16.8 per cent in the white group and 25.7 per cent in the Negro group. The distribution of deaths was, as might have been expected, in relation to the risks.

The differences in mortality between white and Negro patients unfortunately exist whenever comparative studies are made, as they should always be made in series consisting of patients of both races. In Boyce's material on acute appendicitis from Charity Hospital of Louisiana at New Orleans, for instance, which covers an almost sixteen year

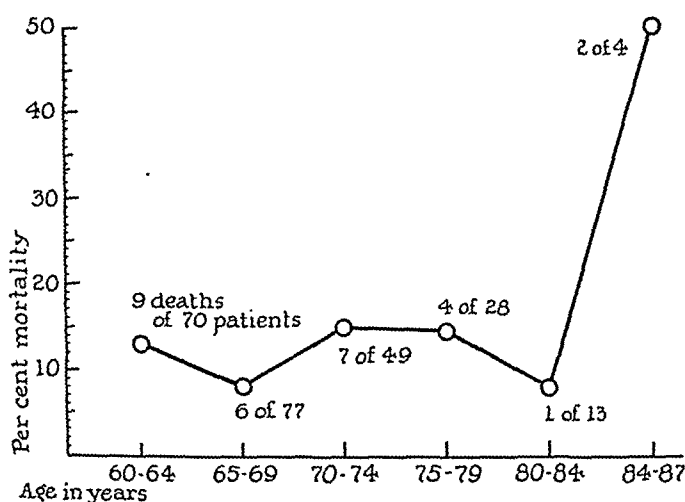


Fig. 4.—Surgical mortality according to age.

period, Negro patients represented less than 30 per cent of the cases but more than 40 per cent of the deaths, the differences being even more pronounced in the upper age groups.

AGE

The 244 patients in this series were between 60 and 87 years of age. There was no sharp differentiation between the risk in the group of patients between 60 and 64 years and in the groups in the upper age brackets (fig. 4). When the statistics are broken down, some of the categories are not large and the fact that there were 2 deaths in the 4 cases in the age group 85 to 89 years is obviously of no significance. It is significant, however, that the variations in mortality in the various age groups seem to indicate that years in themselves do not turn the scale against the patient.

ANESTHESIA

Our opinion as to the role of anesthesia in the surgical mortality of aged persons has not changed from the time of our first report, when we considered it of small importance. There were in this second series no deaths which could be attributed solely to anesthesia, and we continue to believe that the skill and care with which the selected agent is administered make much more difference than the special agent selected. In other words, the anesthetist rather than the anesthetic matters.

A combination of agents was used in most of the 307 operations in this series in which the records contained data on anesthesia (fig. 5); the 15 cases in which the anesthetic agent was not recorded include 3 deaths. On the surface, the figures might suggest the superiority of one or two anesthetic agents over others and thus belie the statements

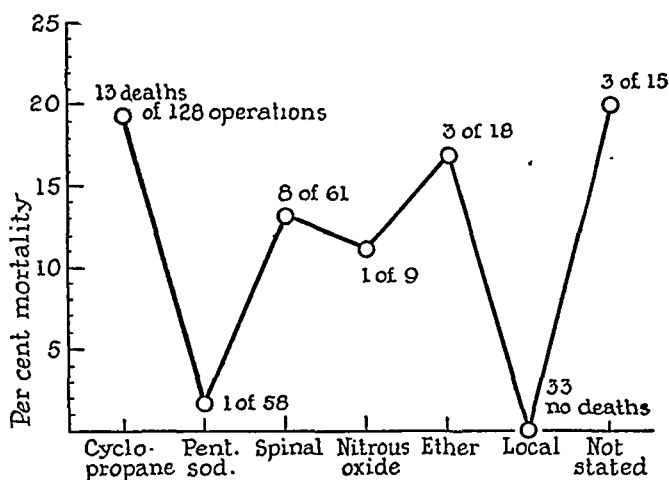


Fig. 5.—Mortality according to anesthesia.

we have just made. The interpretation, however, would be incorrect. Unless the cases were classified as to procedure and as to patient status, any conclusion would be misleading. Thus cyclopropane, for which the proportion of fatalities is highest, was used, on the whole, for the most serious operations, which frequently had to be performed on patients in only fair or in actually poor condition. Pentothal sodium, the use of which was also associated with a low mortality, was used chiefly as an adjuvant agent for gastrointestinal surgery; it was seldom used for prolonged operations. Local analgesia was always used for thyroidec-tomies but otherwise was not employed routinely.

The greatest care was taken in all details of the anesthetic routine. The preanesthetic medication was carefully selected for the individual patient. There was no set routine except that barbiturates were avoided as much as possible, while morphine, which was not always included in the preanesthetic regimen, was always used in small dosages. The

anesthetic plane was as light as was consistent with the necessities of the case. Oxygen was used freely, especially at the conclusion of the procedure. Particular care was taken to avoid variations in the blood pressure. Elderly patients do not tolerate abrupt changes, and a drop of any considerable degree, even in hypertensive patients, may, as Kountz and Jorstad pointed out,⁵ cause disturbances of tissue function and thrombosis of small blood vessels.

TECHNICAL ERRORS

Technical errors should play no greater part in the results of surgical intervention in elderly subjects than in those in young subjects, though the consequence of such errors is far more serious in patients in the upper age brackets because of their lack of physiologic reserve. Obviously, operation should be done by a competent surgeon; the elderly patient cannot withstand the attentions of a surgical novice. There can be no debate over the necessity for perfect asepsis, gentle handling of tissues and complete hemostasis. The loss of small amounts of blood is more serious in the elderly person than in the younger, as Kountz and Jorstad pointed out, because of the lessened ability of the vasomotor system at this age to contract as well as the lessened ability of the heart to increase its rate and output. The instantaneous changes in the vascular system which occur in young persons in response to changing conditions and changing blood volume are an enormous and often an unrealized protection. No such ability exists in the usual elderly patient, and small losses of blood may therefore introduce a major hazard.

So far as we can determine, technical error played a part in only 1 of the 29 fatal cases in this series. When the abdominal incision was being closed in a 71 year old Negro after subtotal gastrectomy for carcinoma of the stomach, the jejunum was inadvertently caught in a suture. An intestinal fistula developed and leakage into the peritoneal cavity caused a subphrenic abscess. Death occurred on the eighteenth post-operative day from this combination of conditions.

Operation on the elderly person should naturally be performed in the shortest period that is consistent with good technic, but surgery, as Wangenstein has been foremost in pointing out, is not a marathon race, and in the properly prepared and properly anesthetized patient prolongation of an operation does not in itself introduce an additional risk. In this series the prolongation of the operation, in some instances to one hundred and eighty minutes, did not seem to be attended with harmful effects, and in no instance did the time spent on the operation seem to have any influence on the final outcome.

5. Kountz, W. B., and Jorstad, L. H.: *Special Problems of Poor Surgical Risks Among the Aged*, *Geriatrics* 1:341, 1946.

NATURE OF THE LESION AND OF THE CORRECTIVE PROCEDURE

The most important factor in the surgical mortality at any period of life is the nature of the disease process and the type of surgical procedure necessary to correct it. This was, of course, true in this series. These considerations can be conveniently analyzed by dividing the operations into elective and emergency ones and operations performed for malignant disease (fig. 6). The difference in the rate between white and Negro groups, already commented on, is evident in these categories too.

These terms, while they scarcely need definition, do need discussion. The emergency group of operations was associated with a relatively small mortality, but even if the deaths had been more numerous, the surgeon had no choice in the matter. In every instance the nature of the process was such that, had operation been withheld, the patient would

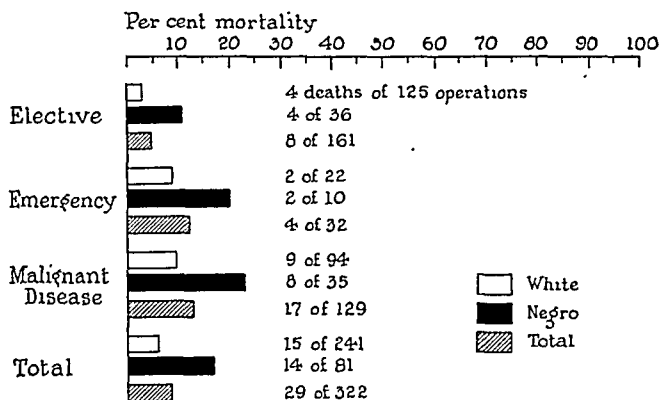


Fig. 6.—Mortality according to nature of lesion (procedure).

have lost his life or might have been left with a permanent disability. In 2 of the 4 fatal cases in this group, moreover, the patients were in such poor condition that the outcome was anticipated even before the operation was undertaken. The 2 other fatal cases in the emergency group represent the unhappy mischances that surgeons sometimes meet: A patient with acute appendicitis, in good condition, died of a pulmonary embolism on the fifteenth day, and a patient subjected to resection for an intestinal obstruction died of cardiorespiratory complications twenty days after closure of the colostomy.

The problem in emergency surgical intervention in the elderly, as at any age, is to prepare the patient as adequately as possible in the briefest possible time. The evaluation of the risk, as has already been intimated, is an academic matter in emergency surgery, though as a matter of fact the proportion of patients in poor condition was relatively small, many being seized with their illness or sustaining their accidents in the midst of good health.

The 89 patients subjected to 129 operations for malignant disease in a sense also represent an inevitable group: They all would have died, just as 17 of them did die after the operation, if treatment had not been instituted. In another sense, of course, they represent a selected group, in that they were subjected to surgical procedures rather than treated with irradiation or with such new agents as mustard gases and isotopes. At this time the latter are not generally available and have not yet been even partially evaluated. The basis of the selection of these patients for surgery was threefold. 1. The lesion was accessible. 2. The risk was not utterly prohibitive. (3). The malignant process was thought to be resectible or the patient's status was such that some sort of palliative procedure was necessary.

The 17 deaths in the malignant group can be viewed with a certain amount of equanimity because death would inevitably have occurred in the absence of treatment, though perhaps it might not have occurred so promptly. This group, however, introduces a delicate problem in surgical ethics. What should be the course of the surgeon in dealing with far advanced malignant disease? Will the patient's lot be happier if he stays his surgical hand? Or will it be improved if some palliative procedure is performed? This decision often cannot be made without exploration, and in no circumstances should this procedure, if it holds out a promise of cure or relief, be withheld merely because it may be followed by a fatal outcome. That is a justifiable, calculated risk. The patients' interests must be weighed in the balance and the decision made in the light of what is best for them.

The patients with malignant disease are not a group which permit any optimism. Seventeen of the 89 died in the hospital, but that is not surprising. Two of the white patients who died were in fair condition when operation was undertaken, and 6 were in poor condition; only 1 of the 9 was in good condition. Of the Negro patients who died, 1 was in fair condition and 7 were in poor condition; there were no good risk cases among the fatalities. Incidentally, 2 Negro patients with malignant disease, both of whom died, required emergency operation. One had a ruptured carcinoma of Meckel's diverticulum with advanced peritonitis, and the other had an incarcerated ventral hernia associated with an advanced ovarian malignant process.

From one point of view the cases in which elective operations were performed are the most important group in this series. In these cases surgical treatment might conceivably have been withheld. The patients might have lived for years, though all of them might have looked forward to discomfort and some of them to dangerous and potentially lethal complications in the future. They would not, however, have lost their lives at once, as 8 of the 126 did. These deaths represent the most

regrettable mortality in the series. Furthermore, it is, for the most part, an unexpected mortality. The patients in this group represented the best surgical risk, 90 being in good condition, 12 in fair condition and only 14 in poor condition. One death occurred in the good risk group, 5 in the fair risk group and 2 in the poor risk group. More attention will be devoted later to these considerations.

The 322 operations in this series represent a wide range of procedures (fig. 7) but need no special comment. Ninety-one, more than a quarter, were for genitourinary conditions in men, chiefly hypertrophy of the prostate. The majority of the gastrointestinal operations were for cancer, as were all but one of the operations on the breast; the single exception was for plasma cell mastitis. The fact that no deaths occurred in the seventeen operations on the thyroid on 11 patients deserves comment, as in several instances the degree of toxicity was extremely high. The 2

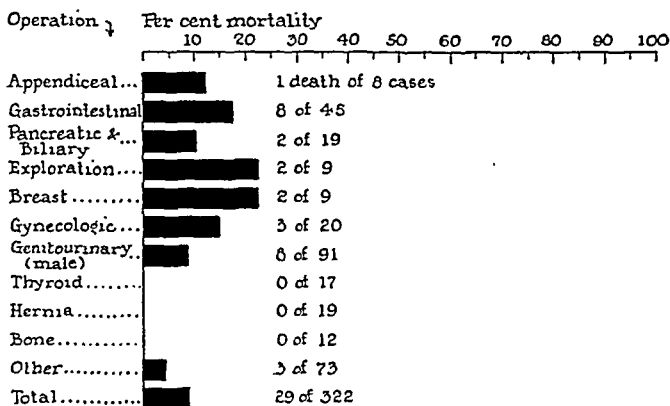


Fig. 7.—Mortality according to operative procedure.

deaths in nine exploratory procedures are a reflection of the poor status of the patients on whom the operations were carried out.

PREOPERATIVE STATUS

Next in importance to the nature of the disease present and the procedure necessary to correct it are the associated complications which exist before operation. Their proper evaluation and management constitute a highly significant factor in the evaluation of the surgical risk, in the development of postoperative complications and in the ultimate mortality. In no other field of medicine is close cooperation between the internist and the surgeon more vital to the patient's welfare. A casual examination on the threshold of the operating room is not sufficient. Preoperative study implies, on the contrary, a careful study of the patient as a whole, with particular reference to his cardiovascular, renal and respiratory systems, his hepatic function and his nutritional status. It

also implies a study of his mental status and spiritual outlook, these intangible factors, as will be pointed out shortly, being extremely important in the elderly patient.

Detailed surveys of this kind naturally cannot be made on patients who must be subjected to emergency surgical treatment, even though in that category there is an irreducible minimum of studies which must be carried out before operation. There is seldom any excuse for an inadequate preoperative evaluation of patients with malignant disease and never an excuse for omitting such studies in patients in the elective group.

Twelve of the 66 Negro patients in this series, 18.2 per cent, and 51 of the 178 white patients, 28 per cent, presented no evidence of preoperative abnormalities. All the remaining patients presented one or more complicating conditions. Some of these conditions, such as orthopedic and minor genitourinary complications, did not influence the end results, but most of them, particularly cardiac and renal complications, were more serious; they accounted for some of the fatalities, and in the absence of proper evaluation and treatment they would undoubtedly have accounted for more.

These complications can be roughly divided into the following groups, in the first three of which there is considerable overlapping:

1. Cardiac, including hypertensive and valvular heart disease, auricular fibrillation, angina pectoris and congestive failure, as well as cardiac enlargement and electrocardiographic abnormalities.

2. Hypertensive, including simple hypertension and hypertension associated with cardiac and renal disease.

3. Renal, including impairment of renal function of various degrees and gross renal disease.

4. Nutritional, including severe anemia, cachexia, malnutrition, dehydration, hypoproteinemia and avitaminosis.

5. Metabolic, chiefly diabetes mellitus.

6. Respiratory, including bronchial asthma, pulmonary emphysema and chronic pulmonary suppuration.

7. Miscellaneous, including psychoses, paralysis agitans, dementia paralytica, hemiplegia and pathologic obesity.

The distribution of complications in general conformed with the distribution of good, fair and poor risks. The patients who underwent the emergency operations, as already mentioned, presented the fewest complications, and the large proportion, particularly of the nutritional variety, was in the group with malignant disease. Generally speaking, too, the severest complications occurred in this group, in which surgical treatment was absolutely essential.

POSTOPERATIVE COMPLICATIONS

The postoperative course of these patients was on the whole remarkably smooth. The twelve respiratory complications, six of which were atelectatic in character, represented the largest single group. There were five instances of wound disruption, almost evenly distributed between Negro and white patients and among the elective, emergency and malignant groups, and three instances of psychoses. The six instances of postoperative hemorrhage all followed operations on the prostate. Among the nonfatal cases there were two instances of phlebothrombosis, in one of which the condition went on to embolism, and one instance of embolism.

This low incidence of complications was accomplished by bringing into play in the postoperative management of the patients all the resources of the modern armamentarium, that is, intravenous therapy, including transfusion; chemotherapy and antibiotic therapy; constant intestinal decompression and early ambulation, or, when this was impossible, directed exercises in bed; oxygen therapy, and such other forms of therapy as seemed indicated in the special case.

It is extremely important that these measures be employed prophylactically in elderly patients subjected to surgical procedures. When complications have actually developed, they are often no longer effective. Elderly patients are particularly prone to respiratory and vascular complications, which they surmount with difficulty. Allen and his associates⁶ are so fearful of vascular complications after operation that they practice venous ligation in patients over 50 years of age who are subjected to operation, and we ourselves are approaching the idea of using dicumarol therapy routinely in these circumstances.

A point of special importance in both preoperative and postoperative therapy is that, important as is the maintenance of a proper fluid balance, it is equally important not to overload the cardiovascular system of the elderly patient. In the upper age groups the introduction of even small amounts of fluid may produce cardiac failure because the cardiovascular system has lost the distensibility of youth. In this same connection Coller's⁷ warning against the excessive use of salt should be remembered. Wangenstein⁸ has suggested that the simplest means of avoiding over-

6. Allen, A. W.; Linton, R. R., and Donaldson, G. A.: Venous Thrombosis and Pulmonary Embolism, *J. A. M. A.* **128**:397 (June 3) 1945.

7. Coller, F. A.; Campbell, K. N.; Vaughan, H. F.; Iob, L. V., and Moyer, C. A.: Postoperative Salt Intolerance, *Ann. Surg.* **119**:533, 1944.

8. Wangenstein, O. H.: Abdominal Surgery in Old Age, Including Comment on (1) Use of Sipper; (2) Safety of Multiple Simultaneous Operations; (3) Mechanism of Development of "Bed Sores," *Journal-Lancet* **64**:178, 1944.

chlorination is to weigh the patient daily, especially the patient who is being treated by constant suction and who therefore cannot gage his own intake.

MORALE

It is scarcely necessary to remind physicians or nurses who have cared for elderly patients that the greatest patience and tact are required for their management. In things that do not matter their established habits should be interfered with as little as is compatible with proper professional care. They do not tolerate restrictions, however reasonable, to which more youthful patients would submit willingly. For this reason they should be gotten out of the hospital and back into their own surroundings as promptly as possible. They require sympathy and tact, and they are particularly susceptible to personal attentions, which from the medical standpoint are not at all necessary but which actually contribute a great deal to their well-being and to their recovery. As Knight and Baird have pointed out, the attitude of resignation and apathy which many older patients display simplifies the task of the anesthetist, though the absence of a fighting spirit becomes a handicap after operation.

ANALYSIS OF DEATHS

It would be of great advantage, though at present it does not seem possible, if one could determine which patients in the elderly group were likely to die, so that surgical treatment could be withheld from them. An analysis of the 8 deaths in this group is not a great help in this connection. It reveals the following facts:

The 4 deaths in the 28 Negro patients all occurred in hypertrophy of the prostate, 3 in patients in fair condition and 1 in a patient in poor condition. There was a renal or a uremic factor in all instances. One patient in the white group who underwent an elective operation also died, of pneumonia, after prostatectomy.

The other 3 deaths in the elective group all occurred in white patients. One, due to coronary thrombosis and sclerosis, followed cholecystectomy in a patient classified as a fair risk, though she presented sinus tachycardia before operation. The second death, which was due to uremia, anuria and acute glomerulonephritis, followed gastrectomy for an old perforated duodenal ulcer in a patient classified as a good risk. The third occurred in a woman subjected to resection of the sigmoid for fibrolipoma. She was in fair condition, in spite of a previous attack of coronary occlusion, and, so far as we could determine, she died merely because she had no special desire to live.

While all the 8 deaths just described occurred in the group of operations classified as elective, in the majority of cases the conditions for

which they were performed were urgent, and in no instance could the operation be considered as anything but necessary.

Only 1 of the 17 deaths following operation for malignant disease occurred in a patient in good condition. This man, who was subjected to one stage abdominoperineal resection for adenocarcinoma of the rectum, had moderate hypertension (158 systolic and 70 diastolic) and albumin (3 plus) in the urine. A severe reaction occurred after every attempt at intravenous therapy, and death followed on the fifth post-operative day from lobar pneumonia. Postmortem examination revealed cardiac hypertrophy and moderate coronary sclerosis, neither condition being sufficient in itself to explain the fatality. Postoperative care in this case was perhaps not as adequate as it might have been; possibly more earnest attempts should have been made to conquer the difficulties with which intravenous therapy was associated.

Most of the deaths from carcinoma could be attributed not so much to the operation performed as to the regrettable state which the patient had reached before surgical intervention was undertaken. Sometimes the advanced disease was the fault of the patient himself, but sometimes it was the fault of the physician, who had failed to make the diagnosis or whose outlook on malignant disease in a patient in the upper age brackets was so somber that he failed to suggest the possibility of surgical treatment while cure was still possible.

Permission for postmortem examination was obtained in 2 of the 14 deaths in Negro patients and in 8 of the 15 deaths in white patients. Even when such studies were made, however, they were not always conclusive, and an attempt to correlate preoperative complications and the causes of death was not entirely satisfactory.

Renal failure was the most frequent cause of death (fig. 8), although only 16 instances of gross renal disease were recognized. It accounted for 9 of the fatalities, in contrast to only 5 fatalities from hypertensive and cardiac complications, which were recognized before operation in 152 patients. One of the cardiac deaths occurred in a patient subjected to an elective operation, who had no preoperative evidence of cardiac disease; it was attributed to advanced coronary sclerosis. There were 3 deaths from congestive failure, and the fourth in a patient with malignant disease was the result of coronary occlusion and cardiac infarction.

The relatively small proportion of deaths from cardiac failure is interesting in view of the belief, which still generally persists, that a patient with cardiac disease is a poor risk for surgical intervention. Actually, if his complicating medical state is properly managed, this is

not true. Studies by Butler, Feeney and Levine⁹ and by Purks¹⁰ some years ago, as well as a recent study by Morrison, make this point clear. Naturally the risk is greater in some varieties of heart disease than in others. According to Morrison,¹¹ whose conclusions are based on 701 operations in 478 patients, the greatest risk is in older subjects with rheumatic heart disease, of which there was no instance in this series.

The second most frequent cause of death in this series was pulmonary embolism, which was clearly responsible for 5 deaths and possibly played a part in a sixth. Exactly what part cardiac and other preoperative complications played in this type of death it is difficult to say, but, as 4

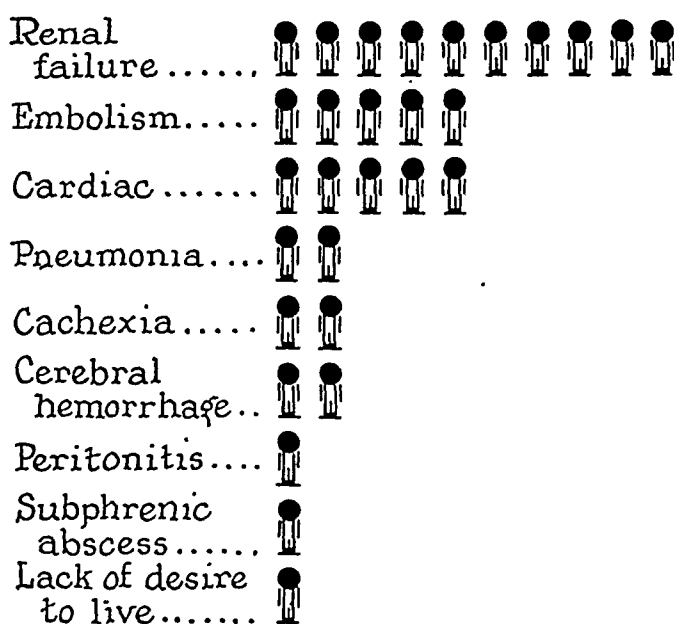


Fig. 8.—Causes of death.

of these 5 fatalities show, they are not the sole explanation of such catastrophes.

Two of the remaining deaths were attributed to pneumonia, 2 to cerebral hemorrhage, 2 to cachexia, and 1 each to peritonitis, subphrenic abscess, and, in the case already mentioned, an apparent lack of desire to live.

We have considered that a relationship exists between the preoperative status and the cause of death when a patient with recognized

9. Butler, S.; Feeney, N., and Levine, S. A.: The Patient with Heart Disease as a Surgical Risk: Review of Four Hundred and Fourteen Cases, *J. A. M. A.* 95:85 (July 12) 1930.

10. Purks, W. K.: The Cause of Death of Patients with Organic Heart Disease Subjected to Surgical Operation, *Ann. Int. Med.* 7:885, 1934.

11. Morrison, D. R.: The Risk of Surgery in Heart Disease, *Surgery* 23:561, 1948.

hypertensive or renal disease dies of uremia, when a hypertensive subject dies of cerebral hemorrhage or when a recognized hypertensive or cardiac subject dies of a cardiac condition. We have also assumed that such factors as extreme obesity, congestive heart failure and severe anemia are predisposing causes of embolism, since the incidence of embolism is higher when they are present. On these grounds, a correlation was demonstrable between the preoperative status and the cause of death in 16 of the 29 fatal cases. Whether all these fatalities could have been averted is questionable, but it is at least fair to say that the possibility of the relationship introduces the need for surrounding the elderly patient all through his hospital course with precautions which may sometimes prove unnecessary but which at other times may avert a fatality.

SUMMARY AND CONCLUSIONS

1. Surgical intervention in elderly persons (over 60 years of age) is becoming a matter of concern to surgeons as the population in this age bracket continues to increase.

2. The factors of mortality, have been analyzed in 322 operations performed on 244 patients in this age group at the Vicksburg Hospital over a recent approximately six year period.

3. There is a sharp difference, in favor of the white race, between the mortality rates in white and Negro subjects, to be explained by the greater proportion of good risks among the white patients. Age itself, anesthesia, technical considerations and duration of operation are not important factors of mortality. The nature of the lesion and the procedure necessary to correct it, together with the preoperative complications present and the manner in which they are handled, ultimately determine whether the patient shall live or die.

4. An endeavor to correlate preoperative status with postoperative mortality, while not entirely successful, even in cases which came to autopsy, permitted the conclusion that in 16 of the 29 fatalities in this series such a correlation existed. Whether all these fatalities could have been prevented is highly doubtful, but there is no doubt of the necessity of surrounding the elderly surgical patient with every care and precaution. They frequently prove unnecessary, but they may be life-saving.

DISCUSSION

DR. WILLARD BARTLETT JR., St. Louis: I have had the pleasure of visiting Dr. Parsons and seeing him work. Those of you who have had a similar experience, and who know how his mind works, readily understand how thoughtfully he has evaluated his own experience.

My generation has seen the rise of the multiple stage operation on persons who present particular handicaps especially from the nutritional point of view. There is obviously a move away from stage operations today, as our ability to evaluate

operative risk, our understanding of biochemical and physiologic derangements and our methods of maintaining life in the seriously depleted persons improve. However, there are still a few procedures for the handicapped group of patients, particularly the aged, that are not regularly receiving as much attention as they deserve.

(Slide) This cholangiogram illustrates one such procedure, the two stage approach to the obstructed common bile duct. The patient shown here is typical of a few persons whom we have handled over the years by this method. I would not put this in print, but we have not had a death in such a patient during my twenty years in practice. This woman was 69 when she came to us in 1933, deeply jaundiced after five years of biliary colic and ten days of jaundice, chills and fever, with obvious cholangitis. Because of her fear of eating over a period of years, her weight had dropped by more than 33 per cent, from an average of 150 pounds (68 Kg.) down to something like 110 or 112 pounds (49.9 to 50.8 Kg.). We opened her gallbladder and cleared it of stones and assured ourselves that the cystic duct was open. After my father's practice, we put a mushroom catheter (which is the only kind you can keep in any hollow viscus, as you know) in her gallbladder. She made a smooth recovery and was discharged from the hospital wearing the catheter clamped.

During the succeeding six months she regained her weight and appetite; her hemoglobin and blood counts were restored to normal. This sidetrack of the biliary tract provides a safety valve, and one frees the patients of the complications of jaundice, including infection. In the cholangiogram you can see the stone at the lower end of the common duct, which in the interval between operations occasionally would impact. During her stages of impaction, in the presence of this self-retaining catheter in the gallbladder, bile would be diverted to the outside, and she would stay free of fever and of evidence of infection and free of jaundice. She would have only mild, transient colic for a day or two, not sufficient to require morphine, and she would not be really incapacitated by these episodes of impaction of the stone.

After six months, with her restoration to essentially normal health, exploration of the duct was done, the stone removed and the gallbladder removed. She was then 70 years old, and is well today at 84. I recommend the procedure for your consideration when dealing with such persons.

DR. R. L. SANDERS, Memphis, Tenn.: It was my privilege to sponsor Dr. Parsons as a member of this association. After hearing his paper today, I am sure you will agree with me that his presentation has been an excellent one.

Dr. Parsons is from the deep South, and his observations are especially noteworthy in that they include both the white and Negro races. In spite of the opinion of certain widows in New York state, we still have Negroes in the South who live more than sixty years. The paper by Drs. Parsons and Purks has clearly shown this fact. No doubt the lives of our Negroes will continue to increase in length; those of us who live in the South like them and appreciate them, and we therefore take good care of them.

It is my opinion that anyone who lives more than sixty years was made of good material in the first place. For this reason, I do not fear to take some risk in operating on elderly persons. They usually withstand major operations well.

DR. W. H. PARSONS, Vicksburg, Miss.: Of course I am in complete agreement with Dr. Bartlett that there is a definite place for stage operations and that in certain circumstances and conditions the surgical risk definitely is lessened by

so wise a choice. I had some difficulty, as most surgeons have, in educating my medical colleagues in the possibilities of operations on elderly patients. It is, however, only fair to state that the co-author of this paper has taught me that elective operations ought not to be done on persons known to be in poor condition. It is better perhaps to permit these patients to make their exitus unaided by the surgeon's hand.

We wish to thank those who have discussed this paper, and finally we wish again to repeat that, in our judgment, elderly patients present definitely a greater surgical risk than younger persons but that this risk, except in dealing with patients having conditions which require emergency operations, can be recognized preoperatively and many of these elderly patients can be made acceptable for surgical procedures, which in fact often will save their lives and even more often will add to their comfort.

CONGENITAL ANORECTAL ATRESIA

Report of a Case

ROBERT J. PATTON, M.D.
SPRINGFIELD, ILL.

THE CONGENITAL malformation wherein a normal anus is separated from a blind rectal pouch is classified by Ladd and Gross¹ as type 4 (fig. 1). It constitutes a small percentage of anorectal anomalies but is reported to bear a high mortality. The following discussion, which concerns only the type 4 anomaly without urogenital fistula, raises the question whether a discarded surgical procedure, transabdominal repair of the defect, may be performed without increased hazard and with satisfactory result.

With the risk of deemphasis of the fundamental problem of the structural fault in cases of this malformation, brief mention will be given of the embryologic developments involved (fig. 2). As the cloaca is divided into separate urogenital and intestinal systems at about the seventh week by the urorectal septum, the perineum is formed. The proctodeum develops from the ectoderm, and an external opening is formed by rupture of the anal membrane about the eighth week. The anal sphincter forms separately. The rectal tube is swollen in two areas, the bulbus analis superiorly and the bulbus terminalis, a transient swelling, inferiorly. An obliteration between these bulbs is probably the cause of the abnormality classified as type 4.

Associated congenital anomalies in other organs are commonly reported and constitute an important factor in the high mortality rate.² Extensive atresia of the rectal pouch or, indeed, of the entire colon may complicate the type 4 anomaly.³

In combining several authors' series in an attempt to establish the incidence and the usual surgical treatment of rectal atresia with normal

Read at the Fifty-Sixth Annual Meeting of the Western Surgical Association, St. Louis, Dec. 4, 1948.

1. Ladd, W. E., and Gross, R. E.: *Abdominal Surgery of Infancy and Childhood*, Philadelphia, W. B. Saunders Company, 1941.

2. (a) Bacon, H. E., and Hering, A. C.: *The Surgical Management of Congenital Malformations of the Anus, Rectum and Colon*, J. Arkansas M. Soc. 45:41 (July) 1948. (b) Wangenstein, O. H.: *Intestinal Obstructions*, ed. 2, Springfield, Ill., Charles C Thomas, Publisher, 1942. (c) Ladd and Gross.¹

3. Bowers, W. F., and Cook, M. M.: *Congenital Atresia of the Pelvic Colon*, Arch. Surg. 34:868-873 (May) 1937. Rhoads, J. E.; Pipes, R. L., and Randall, J. P.: *A Simultaneous Abdominal and Perineal Approach in Operations for Imperforate Anus with Atresia of the Rectum and Rectosigmoid*, Ann. Surg. 127:552-556, 1948.

anus, it becomes apparent that some cases classed as type 4⁴ present merely an anal dimple, and in another report^{2a} cases are grouped together regardless of the presence or absence of a normal anus. However, among 311 cases⁵ the type 4 of anomaly without fistula was encountered in 25 instances (8 per cent).

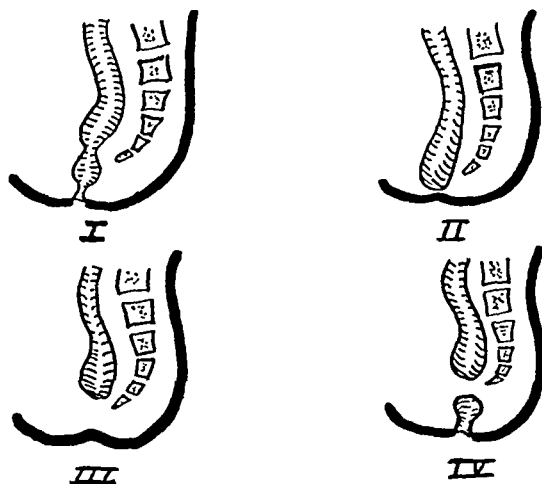


Fig. 1.—Types of anal and rectal abnormalities (after Ladd and Gross).

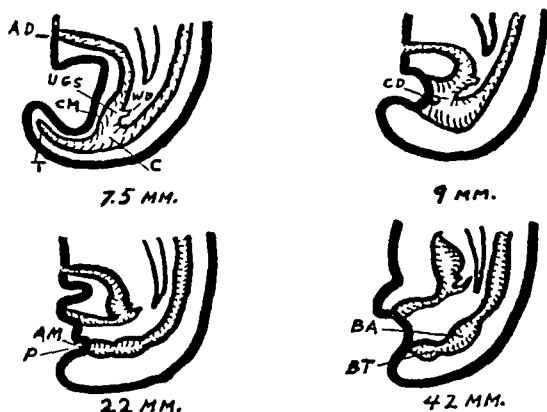


Fig. 2.—Normal development of anus and rectum at 7.5, 9, 22 and 42 mm. stages. AD, allantoic duct; UGS, urogenital septum; CM, cloacal membrane; T, tailgut; WD, wolffian duct; C, cloaca; CD, cloacal duct; AM, anal membrane; P, proctodeum; BA, bulbus analis; BT, bulbus terminalis (after Ladd and Gross).

4. Berman, J. K.: Congenital Anomalies of the Rectum and Anus, *Surg., Gynec. & Obst.* **66**:11-22, 1938.

5. Brenner, E. C.: Congenital Defects of the Anus and Rectum, *Surg., Gynec. & Obst.* **20**:579-588, 1915. Crowell, E. A., and Dulin, J. W.: Congenital Anomalies of the Anus and Rectum, *Surgery* **7**:529-539, 1940. Dmytryk, E. T.: Congenital Malformations of the Anus and Rectum, *Arch. Surg.* **50**:253-257 (May) 1945. Harken, D. E.: Congenital Malformations of the Rectum and Anus, *Surgery* **11**:422-435, 1942. Ladd and Gross.¹

The immediate problem in such cases is the relief of obstruction, whether it be by reestablishment of the continuity of the bowel or by colostomy. The methods and results of treatment are clearly outlined by Ladd and Gross, who cured 4 patients and lost none with primary perineal proctoplasty alone, but this operation was fatal in a like number in whom resort was finally made to colostomy after unsuccessful perineal operations. Colostomy alone resulted fatally in 6 of 7 cases, all poor risks. Two of 3 patients were cured by delayed perineal operation after primary colostomy. A single patient subjected to combined abdomino-perineal operation died. Their total mortality rate in 9 cases was 57 per cent; 6 patients were living and normal, and 2 were living who had permanent colostomy openings.

REPORT OF A CASE

A premature male infant 56 hours of age, weighing 3 pounds 14 ounces (1.7 Kg.), was first seen on May 6, 1946 because he had passed no meconium. He had a weak cry, appeared toxic and was mildly icteric; the abdomen was tensely distended. An enema was not retained and returned clear. A finger inserted into the normal-appearing anus met with a complete obstruction 1.5 to 2.0 cm. above the anal margin; the sphincter appeared normal.

Roentgenograms made with the infant inverted, after the manner suggested by Wangenstein,⁶ and with a hemostat in the anus revealed the gas-filled rectal pouch to lie superior and anterior to the anal pouch and to be separated from the anus by a complete septum (fig. 3). The pouches were too widely separated to undertake incision of the septum with safety.

After preliminary gastric lavage and a transfusion of 45 cc. of blood, the infant was taken to the operating room at the age of 62 hours. The anus was inspected with a small endoscope, and an attempt to discover a lumen in the occluding septum was not successful. Accordingly, under local anesthesia, a sigmoid colostomy was performed, and a catheter was inserted into the proximal limb, which promptly drained meconium freely. Oral feedings were begun on the same day, penicillin was administered and the infant remained in an incubator with supplementary oxygen. Fluids and blood were administered parenterally. His weight dropped to a minimum of 3 pounds 5½ ounces (1.4 Kg.) on the seventh postoperative day. Because the catheter eroded through the bowel at the skin edge and caused some necrosis of the margin of the wound, succinylsulfathiazole was given during the second postoperative week. The colostomy opening was divided on the fifteenth day. He was discharged on the sixty-sixth postoperative day, weighing 5 pounds 14 ounces (1.7 Kg.).

He progressed satisfactorily during the ensuing year and was readmitted for the next stage of the operation at the age of 14½ months. A urethral catheter was placed into the bladder, and another was passed into the distal colostomy loop; a sound was placed into the anal pouch. Ether anesthesia was used, and the abdomen was opened through a lower right rectus incision. The blind rectal pouch was found to terminate beneath the pelvic peritoneum, being fixed to the region of

6. Wangenstein, O. H., and Rice, C. O.: Imperforate Anus, *Ann. Surg.* 92:77-81, 1930.

the base of the bladder, with no evidence of fistula. The anal pouch lay inferior and posterior to the rectal pouch, being separated from it by a distance of several millimeters. An anastomosis was performed between the end of the opened anal pouch and the side of the rectal pouch with a single layer of interrupted fine silk sutures, and the pelvic peritoneum was allowed to fall in place over and above the suture line. A catheter was passed from the anus through the anastomosis and allowed to remain for three days, and a small amount of sulfanilamide powder was dusted about the pelvis before closure. Blood transfusions were given the day prior to operation, during the procedure and in the postoperative period. Penicillin and sodium sulfadiazine were given in the immediate postoperative period, and the use of streptomycin was begun on the third postoperative day because of a sharp febrile reaction which persisted until the sixth day and disappeared slowly



Fig. 3.—Roentgenograms with infant inverted and hemostat in anus depressing obstructing septum. *A*, anteroposterior view; *B*, lateral view.

thereafter. The abdomen was distended, but the colostomy opening functioned. Moderate scrotal edema appeared, and pelvic cellulitis was suspected. Four weeks after operation a no. 14 F. catheter could be passed through the anastomosis and the colostomy opening, and it was left in place; progressively larger catheters were passed at intervals so that the anastomosis contained a no. 26 F. catheter at the time of discharge on the forty-fourth postoperative day, when the patient weighed $16\frac{1}{4}$ pounds (7.4 Kg.).

One week later the catheter was removed, and the index finger could be passed through the stricture with difficulty. The mother was instructed to perform digital dilation daily.

At the age of $25\frac{1}{2}$ months, after preliminary preparation with phthalylsulfathiazole, the redundant colostomy opening was excised, and end to end anastomosis of the sigmoid colon was performed. Penicillin and sodium sulfadiazine were

again administered. The patient passed feces on the fourth day after operation, and was discharged on the twenty-sixth postoperative day with a stricture which easily admitted the index finger.

On subsequent office visits the stricture was found to be dilated rapidly by the normal passage of feces. One year after the final operation the stricture could not be identified by the examining finger and the child was in excellent health, having normal bowel movements and controlled bowel habits.

COMMENT

Because of the normal appearance of the anus in this type of malformation it is reported to be common for these infants to be admitted late for surgical care. Colostomy for relief of obstruction has been condemned by some but is recommended by most authors if the obstruction is long-standing, as in this case.⁷ A primary repair of the defect in an obstructed premature infant would not be technically feasible and would certainly multiply the risk. The delay before definitive repair until the age of 14 ½ months permitted the infant to undergo the procedure in a satisfactory state of health.

The choice of the transabdominal repair is open to question⁸; most authors advise proctoplasty via the perineal approach if the rectal pouch is not too high, and an oblique anastomosis is said to offer less chance for stricture formation. The aim is the restitution of the fecal current between two normal segments of bowel and not between the undescended bowel and the skin as in the more common type 3 anomalies. A direct anastomosis is obviously desirable to preserve the integrity of the lower segment. The route of approach is debatable; the widespread opinion that the transabdominal approach should not be employed has generally been based on the results in patients treated during a period when intestinal anastomoses in general bore a higher mortality than at present. Whether this advice holds awaits the publication of recent case reports. With modern adjuncts such as continuous suction, chemotherapy and antibiotics, surgery of the adult pelvic colon has become less hazardous. Anastomosis from the perineal approach can be extremely difficult in an infant and may require invasion of the peritoneal cavity from below if the rectal pouch is high. Visualization is probably better with the abdominal approach except in the case of an extremely short anal pouch. The severity of the postoperative reaction in the patients treated by perineal proctoplasty is not obvious from the necessarily brief

7. David, V. C.: *Surgery of the Rectum and Anus*, in Lewis, D.: *Practice of Surgery*, Hagerstown, Md., W. F. Prior Company, Inc., 1947. Tuttle, J. P.: *Diseases of the Anus, Rectum and Pelvic Colon*, New York, D. Appleton and Company, 1902. Bacon and Hering.^{2a}

8. Mastin, W. M.: A Résumé of the Surgical Treatment of Anorectal Imperforation in the Newborn, *Surg., Gynec. & Obst.* 7:316-323, 1908.

histories recorded in the larger series of cases. In our case it was severe and might have proved fatal without chemotherapy and antibiotics. The ultimate result two and one-half years after colostomy and nearly one and one-half years after the anorectal anastomosis is considered perfect.

CONCLUSIONS

The type 4 congenital anorectal malformation involves anastomosis of two segments of colon. This can be performed in many cases via the perineal approach. Modern therapeutic accessories permit a transabdominal approach with less hazard than was present at the time that such a procedure was generally discontinued, and this method should probably be reserved as a delayed stage operation for cases which require primary colostomy. Most of the modern therapeutic safeguards did not entirely obviate complications in the case under discussion.

SUMMARY

The embryology and incidence of the type 4 (Ladd and Gross) congenital rectal anomaly are discussed, the adaptable surgical procedures are presented, and the case of a premature infant in whom an excellent result was obtained by delayed transabdominal repair is described.

INDEX TO VOLUME 58

- Abdomen:** See also Gastrointestinal Tract; Pelvis; etc.
colostomy bag, new, single use, disposable, with individually molded collar, 54
hernia into umbilical cord and omphalocele (amniocoele) in newborn, 833
Lymph Nodes: See Lymph Nodes
surgical treatment (transthoracic and abdominothoracic) of carcinoma of esophagus and stomach, 662
volvulus of cecum, with review of 100 cases in literature and report of 6 new cases, 129
- Abnormalities and Deformities:** See also under names of organs and regions, as Bones; Fingers and Toes; Hand; Heart; Muscles; Spine; Tongue; etc.
congenital anomaly and fracture of atlas, 112
congenital defects following maternal rubella, 109
congenital deformities, 107
- Abscess:** See under names of organs and regions, as Colon; etc.
Tuberculous: See Tuberculosis, osteoarthritic
- Acanthosis, hyperkeratosis and "knuckle pads,"** 399
- Accidents:** See also Aviation and Aviators; Trauma; etc.
surgical management of instrumental perforation of esophagus, 739
- Acetabulum:** See Hip
- Achilles Tendon:** See Tendons
- Acromioclavicular Joint:** See Shoulder
- Actinomycosis, extensive, treatment of, 218**
varieties of, 201
- Adenoma of thyroid gland,** 875
- Adipose Tissue:** See Fat; Lipoma
- Adson, A. W.:** Repair of defects in ethmoid and frontal sinuses resulting in cerebrospinal rhinorrhea, 623
- Aeronautics:** See Aviation and Aviators
- Age;** tables for predicting adult height from skeletal age and present height, 561
Old: See Old Age
- Air, Compressed:** See Caisson Disease
- Air Force:** See Aviation and Aviators
- Albright Syndrome:** See Bones, diseases; Osteitis fibrosa
- Alimentary Tract:** See Digestive System
- Allen, J. G.:** Role of splenectomy in thrombopenic purpura, 16
- Allergy:** See Anaphylaxis and Allergy
- Ambulation:** See Surgery
- American Academy of Orthopaedic Surgeons, progress in orthopedic surgery for 1946, review prepared by editorial board of, 89, 189, 352**
- Amniocoele:** See Hernia, umbilical
- Amputation, apparatus and technic, 399**
hemipelvectomy for malignant tumors of bony pelvis and upper part of thigh, 867
Amputation-Stumps, 400
- Analgesia:** See Anesthesia; Pain
- Anaphylaxis and Allergy; histologic and chemical aspects of thrombus formation,** 48
- Anastomosis:** See Blood, vessels
- Anemia, splenic; Gaucher's disease,** 544
- Anesthesia, Cold:** See Cold
- elderly patient as surgical risk; analysis of 322 operations performed on 244 patients 60 years of age and over, 888**
in transthoracic surgery of alimentary tract, 679
Refrigeration: See Cold
- Anesthetics:** See Anesthesia
- Aneurysm, traumatic palmar,** 398
- Angina Pectoris; differential diagnosis of hiatus hernia and coronary artery disease,** 428
- Angle, T. J.:** Acute pancreatitis and its sequelae, 484
- Ankle:** See Foot; etc.
- Ankylosis:** See Hip; Joints; etc.
- Anomalies:** See Abnormalities and Deformities; and under names of organs and regions
- Anoxemia:** See Oxygen, deficiency
- Anoxia:** See Oxygen, deficiency
- Antibiotics:** See also Appendicitis; Penicillin; etc.
development of bacterial resistance to, 213
in surgery of trauma, 228
- Antisepsis and Antiseptics:** See Wounds
- Anus:** See also Rectum
a.orectal complications of intractable colitis, 244
artificial; new, single use, disposable colostomy bag with individually molded collar, 54
congenital anorectal atresia; report of case, 907
- Apparatus:** See also Fractures; Instruments; Orthopedics; etc.
amputations and technic, 399
nonsuture method for vascular anastomosis utilizing Murphy button principle, 504
orthopedic, 403
thumb traction technic for reduction of Colles' fracture, 848
- Appendectomy:** See Appendicitis
- Appendicitis, acute; factors contributing to low mortality from appendectomy; 10 year study,** 171
- Appendix, Abscess:** See Appendicitis
- Armed Forces Personnel:** See Aviation and Aviators; Military Medicine; etc.
- Arms:** See Aviation and Aviators; Military Medicine; War; etc.
- Arms:** See also Extremities; Forearm; Humerus; etc.
lateral rupture of cervical intervertebral disks; common cause of shoulder and arm pain, 102
- Army Air Forces:** See Aviation and Aviators
- Arteries:** See also Aneurysm; Blood pressure; Blood vessels; Embolism; Thrombosis; Vasomotor System; etc.
carotid, complications of injection of thorotrast in, 60
carotid; ligation for advanced malignant neoplasms of head and neck, 35
Coronary: See Coronary Vessels
multiple arterial emboli; 3 successful embolectomies in case of bacterial endocarditis, 28

- Arthritis: See also Osteoarthritis; and under names of joints
and allied conditions in causation of pain in lower part of back, 355
deformans, of hip, radotomy for relief of pain in case of, 92
• differential diagnosis of tuberculosis in joints of extremities, 554
muscle flap transplant for relief of painful monarticular arthritis of hip, 94
pneumococcal, treated with penicillin, 192
resection of obturator nerve in therapy of coxarthria, 91
suppurative, of hip joint, treated with penicillin, 230
tuberculous rheumatism (Poncet's disease), 549
- Arthrodesis: See Foot, deformities; Hip; Joints; Spine; Wrist; etc.
- Arthrokataclasis: See Hip
- Arthroplasty; method for congenital dislocation of hip in children, 239
- Ascites; use of portacaval anastomosis in portal cirrhosis, 590
- Atelectasis: See Lungs, collapse
- Atlas and Axis, fracture; congenital anomaly and fracture of atlas, 112
- Atresia: See Anus
- Atrophy: See under names of organs and regions as Bones, atrophy; etc.
- Atwell, S.: Volvulus of cecum, with review of 100 cases in literature and report of 6 new cases, 129
- Ault, G. W.: Surgical treatment of ulcerative colitis, 243
- Aviation and Aviators; diseases and defects of musculoskeletal system in air-crew trainees, 353
orthopedic surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75
- Axilla; hidden carcinoma of breast, 781
- Axis: See Atlas and Axis
- Bacilli: See Bacteria
- Back, conditions involving lower part of, 352
painful disorders of adipose tissue of, 357
problems of industrial injuries of, 353
- Backache, abnormalities of intervertebral disks in causation of, 362
influence of arthritis and allied conditions in causation of pain in lower part of back, 355
influence of inequality of lengths of lower extremities in producing pain low in back, 354
pain in lower part of back, 352
pain in lower part of back as chief or sole symptom of visceral disease, 358
- Bacteria: See also Staphylococci; etc.
Actinobacilli: See Actinomycosis
development of bacterial resistance to antibiotics, 213
- Bacteriostasis: See Staphylococci
- Banti's Disease: See Anemia, splenic
- Battle Casualties: See Wounds
- Benson, C. D.: Hernia into umbilical cord and omphalocele (amniocoele) in newborn, 833
- Bile Ducts: See also Biliary Tract; Gall-bladder
acute pancreatitis and its sequelae, 484
hemihepatectomy with hepaticojunostomy for irreparable defects of, 753
- Biliary Tract: See also Bile Ducts; Gall-bladder; Liver
situs inversus totalis; statistical review of data on 76 cases with reference to disease of biliary tract, 724
- Bisgard, J. D.: Surgical management of instrumental perforation of esophagus, 739
- Blalock, A.: Aspiration of blood from pericardium in treatment of acute cardiac tamponade after injury; further experience, with report of cases, 463
- Blood: See also Anemia; etc.
aspiration from pericardium in treatment of acute cardiac tamponade after injury; further experience, with report of cases, 463
- Circulation: See also Arteries; Capillaries; Vasomotor System; Veins; etc.
circulation; extent of strangulation of small intestine compatible with life; experimental study, 312
coagulation; use of heparin and dicumarol in active treatment of thromboembolism, 603
platelets; role of splenectomy in thrombopenic purpura, 16
pressure, high; use of portacaval anastomosis in portal cirrhosis, 590
transfusion; aspiration of blood from pericardium in treatment of acute cardiac tamponade after injury; further experience, with report of cases, 463
- Vessels: See also Arteries; Capillaries; Vasomotor System; Veins; etc.
vessels; nonsuture method for vascular anastomosis utilizing Murphy button principle, 504
vessels; revascularization following experimental mesenteric vascular occlusion, 576
vessels; treatment of peptic ulceration by vascular ligation, 455
- Body, height; tables for predicting adult height from skeletal age and present height, 561
- Mind and Body: See Mind, body and mind
- Bogardus, G.: Role of splenectomy in thrombopenic purpura, 16
- Bones: See also under names of bones
abnormalities of musculoskeletal system, 353
and joints, infections of, 189
and joints, operative procedures in tuberculosis of, 558
and joints, tuberculosis of, 546
and joints, use of absorbable substances to obliterate bone cavities and as hemostatic agents in operative procedures on, 220
atrophy; bone growth in paralyzed limb, 541
Deformities: See Abnormalities and Deformities; Osteitis deformans; Polymyelitis; Rickets; etc.
Diseases: See also Osteitis; Osteochondritis; Osteomyelitis; etc.
diseases and defects of musculoskeletal system in air-crew trainees, 353
diseases; fibrous dysplasia, 542
diseases of growing and adult bone, 541
disseminated coccidioidomycosis localized in, 201
Dystrophy: See Bones, atrophy; Bones, growth
eccentro-osteochondrodysplasia (Morquio's disease), 545
felon, 217, 225
Fractures: See Fractures
Graft: See Bones, transplantation
growth in paralyzed limbs, 541, 561
growth; mutational or cleidocranial dysostosis, 114
growth; skeletal development of hand, 375
infarction of, 544

- Bones—Continued
 marrow; role of splenectomy in thrombopenic purpura, 16
 orthopedic surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75
 osteoid osteoma; report of case with probable double lesion, 318
 repair of bony defects associated with osteomyelitis, 207
 tables for predicting adult height from skeletal age and present height, 561
 transplantation, bone grafts for ununited fracture of neck of femur, 93
 transplantation; cancellous bone grafts for infected bone defects, 204
 transplantation; cancellous bone grafts to jaw, 98
 transplantation; follow-up results of surgical treatment for nonunion of carpal scaphoid bone; report of 19 cases, 291
 transplantation; penicillin and bone grafting operations, 218
 transplantation; use of barrel stave grafts in spinal fusion, 42
 transplantation; use of penicillin therapy in conjunction with free bone grafting in infected areas, 204
 Bosworth, D.: Conditions involving shoulder, neck and jaw, 97
 Botallo's Duct: See Ductus Arteriosus
 Bowlegs: See Legs, deformities
 Boyd, F. J.: Thumb traction technic for reduction of Colles' fracture, 848
 Boyd, H. B.: Classification and treatment of trochanteric fractures, 853
 Braces: See Orthopedics
 Brain, surgery; prefrontal lobotomy in management of intractable pain, 731
 Breast; effects on breast of removal of nipple or severing of ducts, 791
 hidden carcinoma of, 781
 Brick, I. B.: Incidence of hiatus hernia and associated lesions diagnosed by roentgen ray, 419
 Bronchi; pathogenesis of postoperative pulmonary atelectasis; experimental study, 489
 suppurative disease of lungs, 819
 Bronchiectasis; suppurative disease of lungs, 819
 Brown, A. M.: Colostomy bag; new, single use, disposable bag with individually molded collar, 54
 Brown, H.: Anesthesia in transthoracic surgery of alimentary tract, 679
 Burnett, W. E.: Cystic emphysema of lungs, 328
 Burns; antibiotics in surgery of trauma, 228
 skin-grafting burned dorsum of hand, 375
 treatment of injuries and burns of hand, 377
 Bursa; non-infectious iliopectineal bursitis, 95
 Bursitis: See Bursa
 Buttocks; hemipelvectomy for malignant tumors of bony pelvis and upper part of thigh, 867
 Caisson Disease; bends (caisson disease) as cause of infarctions of bone, 544
 Calcification: See Bones, growth; Bursa; etc.
 Calvé-Legg-Perthes' Disease: See under Femur
 Camptodactyly: See Fingers and Toes, abnormalities
 Cancer: See under names of organs and regions, as Breast; Colon; Esophagus; Head; Liver; Neck; Stomach; Thyroid; etc.
 surgical approach to, 1
 Capillaries: See also Blood, vessels; Vasomotor System
 role of splenectomy in thrombopenic purpura, 16
 Capitulum: See Humerus
 Carbuncle; surgical problems in patients with diabetes mellitus, 228
 Carcinoma: See Cancer
 Cardia: See Stomach, cancer
 Cardiovascular System: See Arteries; Blood vessels; Heart; Vasomotor System; etc.
 Carothers, R. G.: Thumb traction technic for reduction of Colles' fracture, 848
 Carotid Sinus; ligation of carotid arteries for advanced malignant neoplasms of head and neck, 35
 Carpal Scaphoid: See Scaphoid Bone, Carpal
 Carpus: See Wrist
 Cartilage: See Dyschondroplasia; Osteochondritis; Ribs; etc.
 Casts; classification and treatment of trochanteric fractures, 853
 thumb traction technic for reduction of Colles' fracture, 848
 Catgut: See Hemostasis; Sutures
 Cecitis: See Cecum
 Cecum; phlegmonous cecitis; report of 2 cases, 773
 volvulus, with review of 100 cases in literature and report of 6 new cases, 129
 Cells: See Tissue
 Cellulose, oxidized (oxycel); unfavorable reactions in bed of gallbladder; "retained oxycel sponge syndrome," 182
 use of absorbable substances to obliterate bone cavities and as hemostatic agents in operative procedures on bones and joints, 220
 use of human fibrin foam and thrombin solution as hemostatic agents in general surgery, 284
 Cerebrospinal Fever: See Meningitis
 Cerebrospinal Fluid: See also Spinal Puncture
 repair of defects in ethmoid and frontal sinuses resulting in cerebrospinal rhinorrhea, 623
 Cerebrum: See Brain
 Chemotherapy: See also under names of diseases and chemotherapeutic agents, as Actinomycosis; Antibiotics; Osteomyelitis; Penicillin; Wounds; etc.
 in surgery, 211
 Chest: See Thorax
 Children: See also Infants
 use of penicillin in treatment of acute hematogenous osteomyelitis in, 193
 Chin: See Face; Jaws
 Chondrodysplasia: See Dyschondroplasia
 Chondro-Osteo-Dystrophy: See Bones, atrophy
 Circulation: See Blood, circulation
 Cirrhosis: See under Liver
 Clark, O. R.: Repeated massive intestinal hemorrhage from multiple malignant tumors of jejunum, 701
 Clavicle; review of cervical rib syndrome, 101
 Climacteric; backache in women, 354
 Clubfoot: See Foot, deformities
 Coccidioidomycosis, disseminated; localized in bone, 201
 Cogswell, H. D.: Hidden carcinoma of breast, 780
 Cold; refrigeration anesthesia for amputation, 399

- Colitis, acute fulminating ulcerative, 246
chronic ulcerative, with constitutional and visceral degenerative changes, 244
intractable, anorectal complications of, 244
segmental ulcerative, 245
ulcerative, and acute perforation, 246
ulcerative, and hemorrhage, 245
ulcerative, surgical treatment of, 243
- Colles' Fracture: See Radius, fractures
- Colon: See also Cecum; Gastrointestinal Tract; Intestines
congenital anorectal atresia; report of case, 907
inflammation: See Colitis
obstruction and tumor mass, 245
perforation, abscess and fistula of, 245
polypoid degeneration and carcinoma, 245
polyposis of, 708
- Colostomy: See also Anus, artificial
colon obstruction and tumor mass, 245
new, single use, disposable bag with individually molded collar, 54
perforation, abscess and fistula of colon, 245
- Condon, W. B.: Suppurative disease of lungs, 819
- Constitution: chronic ulcerative colitis with constitutional and visceral degenerative changes, 244
- Contracture, Dupuytren's, 396
inheritance of flexed fingers, 128
ischemic (Volkmann contracture); pathologic conditions involving vasomotor mechanisms, 394
- Convalescence; orthopedic surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75
- Copeland, N. M.: Lymphosarcoma of duodenum; report of case; review of literature, 511
- Coracoclavicular Joint: See Shoulder
- Coronary Vessels, diseases; differential diagnosis of hiatus hernia and coronary artery disease, 428
- Correction in article by Drs. Smathers and Weed "Treatment of Tetanus," (Arch. Surg. 57: 291 [Sept.] 1948), 564
- Costal Cartilages: See Ribs
- Cotton Sutures: See Sutures
- Coxa Vara: See Epiphyses, separation
- Coxitis: See Hip
- Cranium, fractures; repair of defects in ethmoid and frontal sinuses resulting in cerebrospinal rhinorrhea, 623
- Crockett, K. A.: Hiatus hernia, 411
- Curare; tetanus treated as respiratory problem, 478
- Curreri, A. R.: Mediastinal tumors, 797
- Cysts: see under names of organs and regions, as Bones; Lungs; etc.
- Dack, S.: Differential diagnosis of hiatus hernia and coronary artery disease, 428
- Danlos-Ehlers Syndrome: See Joints; Skin, abnormalities
- David, V. C.: Phlegmonous cecitis; report of 2 cases, 773
- Davis, H. A.: Extent of strangulation of small intestine compatible with life; experimental study, 312
- Davis, H. H.: Effects on breast of removal of nipple or severing of ducts, 790
- Deficiency Diseases: See Diet and Dietetics; Nutrition; etc.
- Deformities: See Abnormalities and Deformities
- Derr, J. W.: Revascularization following experimental mesenteric vascular occlusion, 576
- Dextrose; histologic and chemical aspects of thrombus formation, 48
- Diabetes Mellitus, surgical problems in patients with, 228
- Diaphragm, Hernia: See Hernia
- Diarrhea; gastrojejunal fistula, 763
- Diathesis, hemorrhagic; pseudohemophilia or chronic thrombasthenia, 635
- Dicumarol: See Thrombosis
- Diet and Dietetics: See also Nutrition
treatment of chronic osteomyelitis, 202
- Dietrich Nodules: See Anaphylaxis and Allergy
- Digestive System: See also Gastrointestinal Tract; Intestines; Pancreas; Stomach; etc.
anesthesia in transthoracic surgery of alimentary tract, 679
- Disk, Intervertebral: See under Spine
- Dislocations: See under Hip
- Donhauser, J. L.: Volvulus of cecum, with review of 100 cases in literature and report of 6 new cases, 129
- Ductus Arteriosus, patent, diagnosis and surgical treatment of, 612
- Duodenum, lymphosarcoma of; report of case; review of literature, 511
treatment of peptic ulceration by vascular ligation, 455
- Dupuytren Contracture: See Contracture
- Dyschondroplasia; eccentro-osteochondrodysplasia (Morquio's disease), 545
- Dysostosis: See Bones, growth
- Dysplasia, Fibrous: See Bones, diseases
- Dystonia; volvulus of cecum, with review of 100 cases in literature and report of 6 new cases, 129
- Dystrophy: See Bones, atrophy
- Education, Medical; more human attitudes in surgical practice, 565
- Ehlers-Danlos Syndrome: See Joints; Skin, abnormalities
- Elbow; ankylosis cubiti congenita, 116
conditions involving elbow, forearm, wrist and hand, 372
supracondylar process of humerus, 374
- Elman, R.: Surgical forum [gastric resection for duodenal ulcer], 539
- Embolism: See also Thrombosis
extent of strangulation of small intestine compatible with life; experimental study, 312
histologic and chemical aspects of thrombus formation, 48
multiple arterial; 3 successful embolectomies in case of bacterial endocarditis, 28
use of heparin and dicumarol in active treatment of thromboembolism 603
- Embryology: See also Fetus; Teratoma
congenital deformities, 107
- Emergencies; surgical management of instrumental perforation of esophagus, 739
- Emphysema, cystic, of lungs, 328
- Empyema: See Frontal Sinus
- Endocarditis; multiple arterial emboli; 3 successful embolectomies in case of bacterial endocarditis, 28
- Endometriosis; situs inversus with associated abnormalities; review of literature and report of 3 cases, 149
- Enteritis: See Colitis; Diarrhea

- Epidemiology: See under names of diseases, as Poliomyelitis; etc.
- Epidermis: See Skin
- Epiphyses: arrest for equalization of leg length, 562
degenerative osteoarthritis of hip joint; survey of degenerative arthritis secondary to aseptic necrosis of femoral head, 251
epiphyseal coxa valga, 90
slipped capital femoral, 90
- Equinovarus: See Foot, deformities
- Erythrocytes: See Anemia; etc.
- Esophagus; differential diagnosis of hiatus hernia and coronary artery disease, 428
hemorrhage; use of portacaval anastomosis in portal cirrhosis, 590
incidence of hiatus hernia and associated lesions diagnosed by roentgen ray, 419
surgical management of instrumental perforation of, 739
surgical treatment of benign and secondarily malignant tumors of, 646
- Ethmoid Sinus; repair of defects in ethmoid and frontal sinuses resulting in cerebrospinal rhinorrhea, 623
- Exomphalos: See Hernia, umbilical
- Extremities: See also Arms; Legs; and under names of bones
Amputation: See Amputation
Blood Supply: See Blood vessels; Embolism; Thrombosis; etc.
influence of inequality of lengths of lower extremities in producing pain low in back, 354
multiple arterial emboli; 13 successful embolectomies in case of bacterial endocarditis, 28
paralysis; bone growth in paralyzed limb, 541, 561
upper, repair of surface defects of, 376
- Face; facial maxillary injuries and reconstruction, 97, 99
- Fahey, J. J.: Progress in orthopedic surgery for 1946; review prepared by editorial board of American Academy of Orthopaedic Surgeons, 89
- Fascia: See Sutures
- Fat; painful disorders of adipose tissue of back, 357
- Fell-Klippel Syndrome: See Spine, abnormalities
- Felons: See Paronychia
- Femur: See also Hip
bone grafts for ununited fracture of neck of, 93
classification and treatment of trochanteric fractures, 853
degenerative osteoarthritis of hip joint; survey of degenerative arthritis secondary to aseptic necrosis of femoral head, 251
Epiphyses: See Epiphyses
fracture of neck of, 236
head, dysplasia of, 239
internal fixation of trochanteric fractures of, 92
obstetrical dislocation of hip associated with fracture of, 96
osteoid osteoma; report of case with probable double lesion, 318
subtrochanteric osteotomy for ununited fracture of neck of, 92
- Fetus: See also Embryology; Pregnancy
congenital deformities, 107
- Fibrin; use of human fibrin foam and thrombin solution as hemostatic agents in general surgery, 284
- Fibrinogen; histologic and chemical aspects of thrombus formation, 48
- Fibroma; benign nonepithelial tumors of stomach, 529
- Fibrosarcoma; hemipelvectomy for malignant tumors of bony pelvis and upper part of thigh, 867
- Ficarra, B. J.: Ligation of carotid arteries for advanced malignant neoplasms of head and neck, 35
- Fingers and Toes: See also Foot; Hand; etc.
abnormalities; inheritance of flexed fingers, 128
abnormalities; inheritance of zygodactyly, 126
calcareous tendinitis of flexor tendon of finger, 383
Contracture: See under Contracture
general consideration of treatment of injuries of hand, 380
"knuckle pads," 399
reconstruction of thumb and fingers, 388
relationship of extensor digitorum communis tendon to metacarpophalangeal joint, 373
splinting and rehabilitation, 387
stenosing tenosynovitis and tendinitis, 383
suppurative tenosynovitis in fingers, 377
thumb traction technic for reduction of Colles' fracture, 848
treatment of avulsion of extensor tendon of finger, 379
- Fistula, perforation and abscess of colon, 245
gastrojejunoileic, 763
- Flatfoot: See Foot, flat
- Food: See Diet and Dietetics; Nutrition; etc.
- Foot: See also Ankle; Fingers and Toes; etc.
and hand, early covering of traumatic deformities of, 376
congenital abnormalities of, 120
Deformities: See also Poliomyelitis
deformities; hereditary syndrome comprising malformation of tongue and polydactylia, 126
deformities; rotation osteotomy to correct inward torsion in cases of congenital clubfoot, 119
flat, congenital, treatment of, 124
- Foramen, Intervertebral: See under Spine
- Forearm; ankylosis cubiti congenita, 116
conditions involving elbow, forearm, wrist and hand, 372
- Fractures: See also under names of bones and joints, as Atlas and Axis; Femur; etc.
antibiotics in surgery of trauma, 228
penicillin and bone grafting operations, 218
- Freezing: See Cold
- Friedlander, E.: Histologic and chemical aspects of thrombus formation, 48
- Frontal Sinus; repair of defects in ethmoid and frontal sinuses resulting in cerebrospinal rhinorrhea, 623
- Fungi: See Actinomycosis; etc.
- Gale, J. W.: Mediastinal tumors, 797
- Gall Ducts: See Bile Ducts
- Gallbladder: See also Bile Ducts; Biliary Tract
unfavorable reactions to oxidized cellulose (oxycel) in bed of gallbladder; "retained oxycel sponge syndrome," 182
- Galloway, T. C.: Tetanus treated as respiratory problem, 478
- Gangrene; extent of strangulation of small intestine compatible with life; experimental study, 312
- Gaster, J.: Extent of strangulation of small intestine compatible with life; experimental study, 312
- Gastrectomy: See Stomach

- Gastric Juice: See Stomach, secretion
- Gastric Ulcer: See Peptic Ulcer
- Gastroduodenal Ulcer: See Peptic Ulcer
- Gastroenteritis: See Diarrhea
- Gastroenterostomy: See also Peptic Ulcer
treatment of jejunal ulcer; comparative follow-up study, 684
- Gastrointestinal Tract: See also Colon; Digestive Systems; Intestines; Rectum; Stomach; etc.
hiatus hernia, 411
incidence of hiatus hernia and associated lesions diagnosed by roentgen ray, 419
treatment of perforation of gastrojejunal ulcer by resection of stomach and anastomosis, 281
- Gastrojejunal Ulcer: See Peptic Ulcer
- Gastrojejunostomy: See Stomach
- Gastrostomy: See under Peptic Ulcer; Stomach
- Gaucher's Disease: See Anemia, splenic
- Gauze: See Cellulose
- German Measles: See Rubella
- Gibson, S.: Diagnosis and surgical treatment of patent ductus arteriosus, 612
- Gilchrist, R. K.: Phlegmonous cecitis; report of 2 cases, 772
- Gill, A. B.: Congenital dislocation of hip, 236
- Glucose: See Dextrose
- Goeringer, C. F.: Follow-up results of surgical treatment for nonunion of carpal scaphoid bone; report of 19 cases, 291
carcinoma of thyroid gland, 875
- Grafts: See Bones, transplantation; Muscles, transplantation Surgery, plastic; etc.
- Graham, W. C.: Conditions involving elbow, forearm, wrist and hand, 372
- Granuloma, Coccidioidal: See Coccidioidomycosis
Malignant: See Hodgkin's Disease
- Grayzel, D.: Benign nonepithelial tumors of stomach, 529
- Greiner, D. J.: Lymphosarcoma of duodenum; report of case; review of literature, 511
- Griffin, L. L.: Classification and treatment of trochanteric fractures, 853
- Grishman, A.: Differential diagnosis of hiatus hernia and coronary artery disease, 428
- Growth: See also Diet and Dietetics; Embryology; Nutrition; etc.
tables for predicting adult height from skeletal age and present height, 561
- Gunshot Wounds: See Wounds
- Hamilton, F. E.: Prefrontal lobotomy in management of intractable pain, 731
- Hammer Finger: See Fingers and Toes, abnormalities
- Hand: See also Fingers and Toes; Metacarpus and foot, early covering of traumatic deformities of, 376
anomalous innervation of intrinsic muscles of, 372
conditions involving elbow, forearm, wrist and hand, 372
disability evaluation for, 397
infections, 225, 377
infections, acute, use of penicillin in, 229
injuries, treatment of, 380, 382
penicillin and treatment of infected hands in outpatients, 232
primary and secondary repair of nerves and tendons, 381
skeletal development of, 375
- Hand—Continued
skin-grafting burned dorsum of, 375
splinting and rehabilitation, 387
tendon, acute injuries of, 379
tendon transplantation in, 385
traumatic palmar aneurysm, 398
treatment of injuries and burns of, 377
- Harper, F. R.: Suppurative disease of lungs, 819
- Harrington, S. W.: Surgical treatment of benign and secondarily malignant tumors of esophagus, 646
- Hayes, G. J.: Prefrontal lobotomy in management of intractable pain, 731
- Head: See also Cranium
and neck, ligation of carotid arteries for advanced malignant neoplasms of, 35
- Heart: See also Blood, circulation; etc.
abnormalities; diagnosis and surgical treatment of patent ductus arteriosus, 612
aspiration of blood from pericardium in treatment of acute cardiac tamponade after injury; further experience, with report of cases, 463
differential diagnosis of hiatus hernia and coronary artery disease, 428
- Height: See under Body
- Heine-Medin Disease: See Pollomyelitis
- Hematology: See Blood
- Hematoma; traumatic palmar aneurysm, 398
- Hemihypertrophy: See Hypertrophy, unilateral
- Hemipelvectomy: See Amputation
- Hemoglobin and Hemoglobin Compounds: See Anemia; Blood
- Hemopericardium: See Pericardium, hemorrhage
- Hemorrhage: See also Esophagus; Hemostasis; Intestines; etc.
and ulcerative colitis, 245
ligation of carotid arteries for advanced malignant neoplasms of head and neck, 35
use of human fibrin foam and thrombin solution as hemostatic agents in general surgery, 284
- Hemostasis: See also Blood, coagulation; Hemorrhage; etc.
unfavorable reactions to oxidized cellulose (oxycel) in bed of gallbladder; "retained oxycel sponge syndrome," 182
use of absorbable substances to obliterate bone cavities and as hemostatic agents in operative procedures on bones and joints, 220
use of human fibrin foam and thrombin solution as hemostatic agents in general surgery, 284
- Heparin: See also Thrombosis
and penicillin; effect on experimentally produced thrombophlebitis, 163
- Hepatic Ducts: See Bile Ducts
- Heredity; congenital deformities, 107
 situs inversus totalis; statistical review of data on 76 cases with reference to disease of biliary tract, 724
- Hernia: See also Spine, intervertebral disks
differential diagnosis of hiatus hernia and coronary artery disease, 428
hiatus, 411
incidence of hiatus hernia and associated lesions diagnosed by roentgen ray, 419
therapy; present status of injection treatment, 273
traumatic rupture of adductor muscles of thigh, 94
umbilical, and omphalocele (amniotocele) in newborn, 833
- Hiatus Hernia: See Hernia

- Hill, E. J.: Hernia into umbilical cord and omphalocele (amniocoele) in newborn, 833
- Hip: See also Femur
arthrodesis for arthritis, 89
arthrokatadysis, 95
arthroplasty for congenital dislocation of, 239
bilateral extra-articular ankylosis of, 96
conditions involving, 89
coxitis or osteomyelitis in newborn infants and congenital dislocation of, 236
degenerative osteoarthritis; survey of degenerative arthritis secondary to aseptic necrosis of femoral head, 251
dislocation, congenital, 236
dislocation, congenital, treatment of, 237
dislocation; pathomechanics of hip after shelf operation, 240
muscle flap transplant for relief of painful monarticular arthritis of, 94
radicotomy for relief of pain in case of arthritis deformans of, 92
relief of pain in osteoarthritis of, 92
resection of obturator nerve in therapy of coxarthria, 91
suppurative arthritis treated with penicillin, 230
- Hodgkin's Disease; surgical approach to cancer, 1
- Horvitz, T.: Degenerative osteoarthritis of hip joint; survey of degenerative arthritis secondary to aseptic necrosis of femoral head, 251
- Humerus, supracondyloid process of, 374
- Hygroma: See Bursa
- Hyperglycemia: See Diabetes Mellitus
- Hyperkeratosis: See Keratosis
- Hypertension: See Blood pressure, high
- Hypertrophy, unilateral; congenital hemihypertrophy, 118
- Hypothermia: See Cold
- Hypoxia: See Oxygen, deficiency
- Idiosyncrasy: See Anaphylaxis and Allergy
- Ileostomy: See Anus, artificial; Colon
- Industry and Occupations; problems of industrial injuries of back, 353
- Infantile Paralysis: See Poliomyelitis
- Infants: See also Children
newborn, coxitis or osteomyelitis and congenital dislocation of hips in, 236
newborn, hernia into umbilical cord and omphalocele (amniocoele) in, 833
newborn; treatment of congenital dislocation of hip, 237
premature; congenital anorectal atresia; report of case, 907
- Infection: See also Wounds; and under names of bacteria, as Staphylococci; etc.
chemotherapy in surgery, 211
report on use of penicillin in treatment of staphylococcal infections with reference to acute and chronic osteomyelitis and several collateral studies, 194
suppurative disease of lungs, 819
topical use of concentrated penicillin in surface-active solution, 198
use of penicillin therapy in conjunction with free bone grafting in infected areas, 204
- Inflammation: See Colitis; Infection
- Infusions: See Injections
- Injections: See also Blood transfusion; etc.
present status in treatment of hernia, 273
- Injuries: See under Industry and Occupations; Trauma; and under names of organs and regions, as Face; Hand; Wrist; etc.
- Instruments: See also Apparatus; Orthopedics; etc.
diagnosis and surgical treatment of patent ductus arteriosus, 612
new surgical instruments and devices, 406
surgical management of instrumental perforation of esophagus, 739
- Intervertebral Disks: See Spine
- Intestines: See also Cecum; Colon; Duodenum; Gastrointestinal Tract; Rectum; etc.
diseases; phlegmonous cecitis; report of 2 cases, 773
hemihepatectomy with hepaticojejunostomy for irreparable defects of bile ducts, 753
lymphosarcoma of duodenum; report of case; review of literature, 511
repeated massive intestinal hemorrhage from multiple malignant tumors of jejunum, 701
revascularization following experimental mesenteric vascular occlusion, 576
small, extent of strangulation compatible with life; experimental study, 312
- Ulcers: See Peptic Ulcer
volvulus of cecum, with review of 100 cases in literature and report of 6 new cases, 129
- Irwin, C. E.: Infantile paralysis, 561
- Islands of Langerhans: See Pancreas
- Jackson, A. S.: Carcinoma of thyroid gland, 875
- Jacobson, L. O.: Role of splenectomy in thrombopenic purpura, 16
- Jaws, ankylosis of, 99
cancellous bone grafts to, 98
conditions involving shoulder, neck and jaw, 97
condylar movement in study of internal derangement of temporomandibular joint, 98
facial maxillary injuries and reconstruction, 97, 99
- Jejunum: See under Intestines
Ulcer: See Peptic Ulcer
- Johnson, J. R.: Situs inversus with associated abnormalities; review of literature and report of 3 cases, 149
- Joints: See also under names of individual joints, as Ankle; Elbow; Hip; Wrist; etc.
and bones, infections of, 189
and bones, operative procedures in tuberculosis of, 558
and bones, tuberculosis of, 546
and bones, use of absorbable substances to obliterate bone cavities and as hemostatic agents in operative procedures on, 220
Ehlers-Danlos syndrome, 545
Inflammation: See Arthritis
- Jurisprudence, Medical; medicolegal aspects of herniated disks, 364
- Keratosis; acanthosis and hyperkeratosis and "knuckle pads", 399
- Kerr, H. H.: Surgical management of instrumental perforation of esophagus, 739
- Kite, J. H.: Congenital deformities, 107

- Klippel-Fell Syndrome: See Spine, abnormalities
- Köhler's Disease: See Scaphoid Bone, Tarsal
- Koontz, A. R.: Present status of injection treatment of hernia, 273
- Kyphosis: See Spine, curvature
- Lacey, H. B.: Orthopedic surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75
- Lactation; effects on breast of removal of nipple or severing of ducts, 791
- Laennec's Disease: See Liver, cirrhosis
- Langerhans' Islands: See Pancreas
- Lapidus, P. W.: Osteoid osteoma; report of case with probable double lesion, 318
- Lawton, S. E.: Gastrojejunocolic fistula, 762
- Lee, W. F., Jr.: Acute pancreatitis and its sequelae, 484
- Legg-Perthes-Calvé's Disease: See under Femur
- Legs: See also Extremities; Foot; and under names of bones and joints
- Amputation: See Amputation
- deformities; nonrachitic bowlegs, 544
- length, epiphyseal arrest for equalization of, 562
- Lelomyoma; benign nonepithelial tumors of stomach, 529
- surgical treatment of benign and secondarily malignant tumors of esophagus, 646
- Lelomyosarcoma; surgical treatment of benign and secondarily malignant tumors of esophagus, 646
- LeVeen, H. H.: Nonsuture method for vascular anastomosis utilizing Murphy button principle, 504
- Lewin, P.: Infections of bones and joints, 189
- Life, duration; elderly patient as surgical risk; analysis of 322 operations performed on 244 patients 60 years of age and over, 888
- Ligaments: See Ankle; Wrist
- Ligatures: See Sutures
- Lipoma; benign nonepithelial tumors of stomach, 529
- painful disorders of adipose tissue of back, 357
- Liver: See also Biliary Tract
- hemihépatectomy with hepaticojejunostomy for irreparable defects of bile ducts, 753
- Liver; use of portacaval anastomosis in portal cirrhosis, 590
- Lobotomy: See Brain, surgery
- Longevity: See Life, duration; Old Age
- Luck, J. V.: Orthopedic surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75
- Lumbar Puncture: See Spinal Puncture
- Lumbosacral Region: See Backache; Spine
- Lungs: See also Bronchi; Respiration; Respiratory Tract; Thorax; etc.
- cystic emphysema of, 328
- collapse; pathogenesis of postoperative pulmonary atelectasis; experimental study, 489
- collapse; suppurative disease of lungs, 819
- Tuberculosis: See Tuberculosis
- Lurje, A.: Treatment of perforation of gastrojejunal ulcer by resection of stomach and anastomosis, 281
- Lymph Nodes: See also Lymphosarcoma
- hidden carcinoma of breast, 781
- Lymphatic System: See also Lymph Nodes
- surgical approach to cancer, 1
- Lymphogranuloma, Hodgkin's: See Hodgkin's Disease
- Lymphosarcoma of duodenum; report of case; review of literature, 511
- McCarroll, H. R.: Use of barrel stave grafts in spinal fusion, 42
- McGraw, A. B.: Factors contributing to low mortality from appendectomy for acute appendicitis; 10 year study, 171
- McLaughlin, C. W., Jr.: Pseudohemophilia or chronic thrombasthenia, 635
- Malformations: See Abnormalities and Deformities; under names of organs and regions
- Mammary Gland: See Breast
- Mandible: See Jaws
- Marks, A. R.: Gastrojejunocolic fistula, 763
- Marsh, R. L.: Extent of strangulation of small intestine compatible with life; experimental study, 312
- Mastectomy: See under Breast
- Master, A. M.: Differential diagnosis of hiatus hernia and coronary artery disease, 428
- Maxillary Bone: See Jaws
- Mayo, C. W.: Situs inversus totalis; statistical review of data on 76 cases with special reference to disease of biliary tract, 724
- Measles, German: See Rubella
- Mediastinum; tumors, 797
- Medicine, Military: See Military Medicine
- Psychosomatic: See Mind, body and mind
- Medin-Heine Disease: See Poliomyelitis
- Megakaryocytes: See Bones, marrow
- Meningitis; repair of defects in ethmoid and frontal sinuses resulting in cerebrospinal rhinorrhea, 623
- Meningomyelocele with spina bifida, 118
- Merendino, K. A.: Unfavorable reactions to oxidized cellulose (oxycel) in bed of gallbladder; "retained oxycel sponge syndrome," 182
- Mesentery; revascularization following experimental mesenteric vascular occlusion, 576
- Metacarpus; relationship of extensor digitorum communis tendon to metacarpophalangeal joint, 373
- Metatarsus: See Foot
- Military Medicine: See also Aviation and Aviators; etc.
- refrigeration anesthesia for amputation, 399
- Mills, W. M.: Repeated massive intestinal hemorrhage from multiple malignant tumors of jejunum, 701
- Mind, body and mind; orthopedic surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75
- body and mind; psychosomatic backache, 359
- Morbidity: See Vital Statistics
- Morquio's Disease: See Dyschondroplasia
- Mortality: See Vital Statistics
- Morton, J. J.: Surgical approach to cancer, 1
- Movements: See Muscles
- Mucin: See Peptic Ulcer; Stomach, secretion

- Mucus:** See Bronchi
- Murphy Button:** See Blood vessels
- Muscles; abnormalities of musculoskeletal system, 353**
 diseases and defects of musculoskeletal system in air-crew trainees, 353
- Dystrophy:** See Dystrophy
- Inflammation:** See Myositis
- innervation; anomalous, of intrinsic muscles of hand, 372**
- orthopedic surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75**
- rectus abdominis; granular cell myoblastoma of anterior rectus sheath, 450**
- transplantation for relief of painful monarticular arthritis of hip, 94**
- transplantation; treatment of chronic osteomyelitis by use of muscle transplant or iliac graft, 216**
- traumatic rupture of adductor muscles of thigh, 94**
- Myoblastoma, granular cell, of anterior rectus sheath, 450**
- Myositis, traumatic ossifying, 546**
- Narcosis:** See Anesthesia
- Navicular Bones:** See Scapoid Bone, Carpal
- Neck and head, ligation of carotid arteries for advanced malignant neoplasms of, 35**
 complications of injection of thorotrast in carotid artery, 60
 conditions involving shoulder, neck and jaw, 97
 etiologic factors in spasmodic torticollis, 100
- Necrosis:** See Femur
- Negroes; elderly patient as surgical risk; analysis of 322 operations performed on 244 patients 60 years of age and over, 888**
- Neoplasms:** See Cancer
- Nerves:** See also Paralysis
 and tendons, primary and secondary repair of, 381
 obturator; resection in therapy of coxarthria, 91
 radicotomy for relief of pain in case of arthritis deformans of hip, 92
- Nervous System:** See Brain; Nerves; etc.
- Neurectomy:** See Nerves, obturator
- Neuritis; prognosis in so-called sciatic neuritis, 367**
- Neurofibroma; benign nonepithelial tumors of stomach, 529**
- Neurosis and Psychoneurosis; orthopedic surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75**
- Newborn Infants:** See Infants, newborn
- Nipple:** See Breast
- Noer, R. J.: Revascularization following experimental mesenteric vascular occlusion, 576**
- Nose, discharge; repair of defects in ethmoid and frontal sinuses resulting in cerebrospinal rhinorrhea, 623**
- Nucleus Pulposus:** See Spine, intervertebral disks
- Nutrition:** See also Diet and Dietetics; Disorders; gastrojejunocolic fistula, 763
- Obstetrics:** See also Pregnancy; etc.
 obstetrical dislocation of hip associated with fracture of femur, 96
- Occupations:** See Industry and Occupations
- Odell, R.: Use of barrel stave grafts in spinal fusion, 42**
- Odontoid Process:** See Atlas and Axis
- Old Age:** See also Life, duration
 elderly patient as surgical risk; analysis of 322 operations performed on 244 patients 60 years of age and over, 888
- Olecranon:** See Ulna
- Olwin, J. H.: Use of heparin and dicumarol in active treatment of thromboembolism, 603**
- Omphalocele:** See Hernia, umbilical
- Orthopedics:** See also Amputation; Bones; Fractures; etc.
 apparatus, 403
 new surgical instruments and devices, 406
 progress in orthopedic surgery for 1946; review prepared by editorial board of American Academy of Orthopaedic Surgeons, 89, 189, 236, 352, 541
 surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75
 treatment of tuberculous wounds in orthopedic cases, 557
- Os Capitatum:** See Wrist
- Ossification:** See also Bones, growth
 of coracoclavicular ligament following dislocation of acromioclavicular articulation, 103
- Osteitis deformans, 541**
 fibrosa; fibrous dysplasia of bone, 542
- Tuberculous:** See Tuberculosis, osteoarthritic
- Osteoarthritis, degenerative, of hip joint; survey of degenerative arthritis secondary to aseptic necrosis of femoral head, 251**
 of hip, relief of pain in, 92
 suspected osteoarthritic tuberculosis, 556
- Osteochondritis, ischium-ischiopubic, 95**
- Osteochondrodysplasia:** See Dyschondroplasia
- Osteogenesis:** See Bones, growth
- Osteoma, osteoid; report of case with probable double lesion, 318**
- Osteomyelitis, acute hematogenous; clinical diagnosis, prognosis and treatment, 189**
 acute hematogenous, in children; use of penicillin in treatment, 193
 acute hematogenous, nonoperative treatment; preliminary report, 224
 acute hematogenous, outline of treatment of, 233
 acute hematogenous, treated with penicillin, 194
 acute, penicillin in treatment of, 225
 acute staphylococci; treatment with penicillin and without surgical operation, 191
 chronic, as sequel to gunshot wound, 232
 chronic, in war wounded, 231
 chronic, penicillin in treatment of, 214
 chronic sclerosing, 191
 chronic, treatment, 202
 chronic; treatment by use of muscle transplant or iliac graft, 216
 nonoperative treatment with penicillin, 199
 or coxitis in newborn infants and congenital dislocation of hips, 236
 pyogenic, differential diagnosis with reference to tuberculosis, 553
 repair of bony defects associated with, 207

- Osteomyelitis**—Continued
 report on use of penicillin in treatment of staphylococcal infections with reference to acute and chronic osteomyelitis and several collateral studies, 194
salmonella, 192
 secondary to war wounds, management of, 200
 skin grafting in treatment of osteomyelitic war wounds, 206
 traumatic, 204
- Osteoporosis**: See *Bones*, atrophy
- Osteosclerosis**, 545
- Oxycel**: See *Cellulose*
- Oxygen**: See also *Respiration*
 deficiency; tetanus treated as respiratory problem, 478
- Paget's Disease**: See *Osteitis deformans*
- Pain**: See also *Backache*
 epigastric; hiatus hernia, 411
 intractable, prefrontal lobotomy in management of, 731
 psychogenic; orthopedic surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75
 relief in osteoarthritis of hip, 92
 relief; radicotomy in case of arthritis deformans of hip, 92
 thoracic; differential diagnosis of hiatus hernia and coronary artery disease, 428
- Palsy**: See *Paralysis*
- Pancreas**; acute pancreatitis and its sequelae, 484
- Pancreatitis**; acute, and its sequelae, 484
- Pantopaque (Iodine Preparation)**: See *Spinal Canal Roentgenography*
- Paralysis**: See *Extremities*; *Poliomyelitis*
 Infantile: See *Poliomyelitis*
 Radial: See *Wrist Drop*
 Volkmann's: See *Contracture*
- Paraplegia**: See *Spine*, tuberculosis
- Pareira, M. D.**: Reaction in surgical wounds to surgical gut, silk and cotton sutures, 308
- Paronychia**; bone felon, 217, 225
- Parsons, W. H.**: Elderly patient as surgical risk; analysis of 322 operations performed on 244 patients 60 years of age and over, 888
- Patella Cubiti**: See *Elbow*
- Patients**: See *Physicians*, relation to patients
- Pattison, A. C.**: Use of portacaval anastomosis in portal cirrhosis, 590
- Patton, R. J.**: Congenital anorectal atresia; report of case, 907
- Pelvis**; backache in women, 354
 hemipelvectomy for malignant tumors of bony pelvis and upper part of thigh, 867
- Penberthy, G. C.**: Hernia into umbilical cord and omphalocele (amniocoele) in newborn, 833
- Penicillin** and heparin, effect on experimentally produced thrombophlebitis, 163
 concentrated, topical use in surface-active solution, 198
 products, silly names for, 189
 Therapy: See also *Arthritis*; *Carbuncle*; *Diabetes Mellitus*; *Endocarditis*; *Fractures*; *Hand*, infections; *Osteomyelitis*; *Staphylococci*; *Tendons*; *Tuberculosis*; *osteoarthritic*
 therapy; use in conjunction with free bone grafting in infected areas, 204
- Peptic Ulcer**; gastric resection for duodenal ulcer, 539
 gastrojejunocolic fistula, 763
 treatment of jejunal ulcer; comparative follow-up study, 684
 treatment of peptic ulceration by vascular ligation, 455
 treatment of perforation of gastrojejunal ulcer by resection of stomach and anastomosis, 281
- Pericardium**, hemorrhage; aspiration of blood from pericardium in treatment of acute cardiac tamponade after injury; further experience, with report of cases, 463
- Peritonitis**: See *Appendicitis*
- Perthes-Calvé-Legg Disease**: See under *Femur*
- Phalanges**: See *Fingers* and *Toes*
- Phlebothrombosis**: See *Thrombophlebitis*
- Phlegmon**: See *Cecum*
- Physicians**, relation to patients; more human attitudes in surgical practice, 565
- Pines, B.**: Benign nonepithelial tumors of stomach, 529
 Effect of heparin and penicillin on experimentally produced thrombophlebitis, 163
- Plasma**: See *Blood*
- Plaster of Paris**: See *Casts*
- Plastic Surgery**: See *Surgery*, plastic
- Pneumococci**, arthritis treated with penicillin, 192
- Pneumonia**; pathogenesis of postoperative pulmonary atelectasis; experimental study, 489
- Pneumonitis**: See *Lungs*
- Poliomyelitis**; infantile paralysis, 561
- Polyarthritis**: See *Arthritis*
- Polydactylia**: See *Foot*, deformities
- Polyposis**: See *Colon*
- Poncet's Disease**: See *Arthritis*, tuberculous
- Pontius, G. V.**: Polyposis of colon, 708
- Portal Vein**; nonsuture method for vascular anastomosis utilizing Murphy button principle, 504
 use of portacaval anastomosis in portal cirrhosis, 590
- Pott's Disease**: See *Spine*, tuberculosis
- Potts, W. J.**: Diagnosis and surgical treatment of patent ductus arteriosus, 612
- Pregnancy**: See also *Fetus*
 congenital defects following maternal rubella, 109
- Premature Infants**: See *Infants*, premature
- Pritel, P. A.**: Extent of strangulation of small intestine compatible with life; experimental study, 312
- Prosthesis**: See *Buttocks*
- Prothrombin**: See *Blood*, coagulation
- Pseudohemophilia**: See *Diathesis*, hemorrhagic
- Psychology**; orthopedic surgery in Army Air Forces during World War II; psychologic problems, convalescent care and rehabilitation, 75
- Pulse**: See *Blood pressure*
- Purks, W. K.**: Elderly patients as surgical risk; analysis of 322 operations performed on 244 patients 60 years of age and over, 888
- Purpura**, haemorrhagica; pseudohemophilia or chronic thrombasthenia, 635
 haemorrhagica; role of splenectomy in thrombopenic purpura, 16
- Thrombopenic**: See *Purpura*, haemorrhagica

- Rabinovitch, J.** Benign nonepithelial tumors of stomach, 529
Effect of heparin and penicillin on experimentally produced thrombophlebitis, 163
- Races:** See Negroes
- Rachitis.** See Rickets
- Radiations.** See also Roentgen Rays
- Radioulnar Joint:** See Wrist
- Radius, fractures, rupture of extensor pollicis longus tendon following Colles' fracture, 385**
thumb traction technic for reduction of Colles' fracture, 848
- Raney, R. B.:** Conditions involving lower part of back, 352
- Ransom, H. K.:** Treatment of jejunal ulcer, comparative follow-up study, 684
- Ravitch, M. M.** Aspiration of blood from pericardium in treatment of acute cardiac tamponade after injury; further experience, with report of cases, 463
- Recklinghausen's Disease:** See Osteitis fibrosa
- Rectum, anorectal complications of intractable colitis, 244**
congenital anorectal atresia; report of case, 907
- Refrigeration.** See Cold
- Rehabilitation.** See also Amputation, etc and splinting, 387
orthopedic surgery in Army Air Forces during World War II, psychologic problems, convalescent care and rehabilitation, 75
- Research; repair of bony defects associated with osteomyelitis, 207**
- Respiration, artificial; tetanus treated as respiratory problem, 478**
- Respirator.** See Respiration, artificial
- Respiratory Tract.** See also Bronchi, Nose, etc
cystic emphysema of lungs, 328
tetanus treated as respiratory problem, 478
- Rhabdomyosarcoma; hemipelvectomy for malignant tumors of bony pelvis and upper part of thigh, 867**
- Rheumatism.** See Arthritis, Osteoarthritis
- Rhinorrhea.** See Nose, discharge
- Ribs, cervical; situs inversus with associated abnormalities; review of literature and report of 3 cases, 149**
review of cervical rib syndrome, 101
- Rice, R. G.** Situs inversus totalis statistical review of data on 76 cases with special reference to disease of biliary tract, 724
- Richards, G. G.** Hiatus hernia, 411
- Rickets, 544**
- Riker, W. L.** Diagnosis and surgical treatment of patent ductus arteriosus 612
Phlegmonous ecchitis; report of 2 cases, 773
- Roentgen Rays, incidence of hiatus hernia and associated lesions diagnosed by, 419**
radiographic analysis of spondylolisthesis, 371
roentgenographic diagnosis (pantopaque) of protrusions of disks, 366
- Rogers, S. S.** Granular cell myoblastoma of anterior rectus sheath 450
- Rubella, maternal, congenital defects following, 109**
- Sacroiliac Joint, topography, 359**
treatment of sacroiliac sprain, 356
- Sacrum, anatomy, development and growth of human sacral vertebrae 359**
transverse sacral folds, 359
- Salem, E. P.** Osteoid osteoma; report of case with probable double lesion, 318
- Salmonella osteomyelitis, 192**
- Sanders, R. L.** Hemihepatectomy with hepaticojunostomy for irreparable defects of bile ducts, 752
- Sarcoma.** See Cancer, Fibrosarcoma, Leiomyosarcoma, Lymphosarcoma, Rhabdomyosarcoma, and under names of organs and regions, etc
- Scalp, total avulsion of, 97**
- Scaphoid Bone, Carpal, follow-up results of surgical treatment for nonunion, report of 19 cases, 291**
- Sciatica, 359**
prognosis in so-called sciatic neuritis, 367
- Scoliosis.** See Spine, curvature
- Scott, H. W., Jr.** Multiple arterial emboli, 3 successful embolectomies in case of bacterial endocarditis, 28
- Senility.** See Old Age
- Sesamoid Bone.** See Fingers and Toes
- Shands, A. R., Jr.:** Orthopedic surgery in Army Air Forces during World War II, psychologic problems, convalescent care and rehabilitation, 75
- Shields, R. T., Jr.** Pathogenesis of post-operative pulmonary atelectasis; experimental study, 489
- Shoulder.** See also Clavicle, Humerus conditions involving shoulder, neck and jaw, 97
injuries to, 104
lateral rupture of cervical intervertebral disk, common cause of shoulder and arm pain, 102
lesions of, 103
lesions of musculotendinous cuff of, 105
ossification of coracoclavicular ligament following dislocation of acromioclavicular articulation, 103
- Siegling, P. A.** Diseases of growing and adult bone, 541
- Silk Sutures.** See Sutures
- Situs Inversus:** See Viscera, transposition
- Skeleton.** See Bones
- Skin, abnormalities; Ehlers-Danlos syndrome, 545**
Hemorrhage. See Purpura
transplantation; burned dorsum of hand, 375
transplantation in treatment of osteomyelitic war wounds, 206
transplantation, management of osteomyelitis secondary to war wounds, 200
transplantation; repair of surface defects of upper extremities, 376
- Skull.** See Cranium
- Smith, A. D.** Tuberculosis of bones and joints, 546
- Smith, H. M. A.** Orthopedic surgery in Army Air Forces during World War II, psychologic problems, convalescent care and rehabilitation, 75
- Smith, S.** Diagnosis and surgical treatment of patent ductus arteriosus 612
- Soldiers.** See Military Medicine
- Spina Bifida, situs inversus with associated abnormalities, review of literature and report of 3 cases, 149**
with meningomyelocele, 118
- Spinal Canal Roentgenography in diagnosis of protrusions of disks, 366**
- Spinal Fluid.** See Cerebrospinal Fluid
- Spinal Puncture.** collapsed disks following lumbar puncture, 367

- Spine** See also Atlas and Axis, Sacrum
 abnormalities, review of Klippel-Feil syn-
 drome, 113
 curvature, use of barrel stave grafts in
 spinal fusion, 42
 differential diagnosis of pyogenic osteo-
 myelitis with reference to tuberculosis,
 553
 dislocations, radiographic analysis of
 spondylolisthesis, 371
 dislocations, spondylolysis and spondylo-
 listhesis, 370
 dislocations, use of barrel stave grafts
 in spinal fusion, 42
 herniation of cervical intervertebral disk,
 102
 intervertebral disks, 361
 intervertebral disks, abnormalities in causa-
 tion of backache, 362
 intervertebral disks, collapsed, following
 lumbar puncture, 367
 intervertebral disks, foraminotomy, 369
 intervertebral disks, herniated, medicolegal
 aspects of, 364
 intervertebral disks, fantom nucleus pul-
 posus, 362
 intervertebral disks, protruding, syndrome
 of, 363
 intervertebral disks, roentgenographic diag-
 nosis (pantopaque) of protrusions of, 366
 intervertebral disks ruptured, diagnosis of,
 365
 intervertebral disks, surgical treatment of
 lumbar disk disease 368
 isthmus defects of lumbar vertebrae, 371
 lateral rupture of cervical intervertebral
 disks, common cause of shoulder and
 arm pain, 102
 situs inversus with associated abnormali-
 ties, review of literature and report of
 3 cases, 149
 tuberculosis, 555
 tuberculosis paraplegia in, 550
 tuberculous spondylitis, 552
Splenectomy, role in thrombopenic purpura, 16
Splints See also Casts
 apparatus, 403
 splinting and rehabilitation, 387
 treatment of congenital flat-foot, 124
Spondylarthritis See Spine
Spondylitis See Spine
Spondylolisthesis See Spine, dislocations
Sprains See Sacroiliac Joint
Spurr, C. L. Role of splenectomy in throm-
 bopenic purpura 16
Staphylococci, infections, action of penicillin
 on, 197
 penicillin in treatment of acute osteomye-
 litis, 225
 report on use of penicillin in treatment of
 staphylococcal infections with special
 reference to acute and chronic osteomye-
 litis and several collateral studies, 194
 treatment of acute staphylococcal osteo-
 myelitis with penicillin and without surgi-
 cal operation, 191
State D. Use of human fibrin foam and
 thrombin solution as hemostatic agents
 in general surgery, 234
Still's Disease See Arthritis, rheumatoid
Stomach See also Gastrointestinal Tract
 benign nonepithelial tumors of, 529
 differential diagnosis of hiatus hernia and
 coronary artery disease, 428
 resection for duodenal ulcer 539
 resection, treatment of jejunal ulcer, com-
 parative follow-up study 684
 secretion treatment of peptic ulceration
 by vascular ligation, 455
 treatment of perforation of gastrojejunal
 ulcer by resection of stomach and anas-
 tomosis, 281
 Ulcers See Peptic Ulcer
- Stone, J.** Differential diagnosis of hiatus
 hernia and coronary artery disease, 428
Strohl, E. L. Polyposis of colon, 708
Sudeck's Disease See Bones atrophy
Sulfonamides, Therapy See Appendicitis
Surgery See also Apparatus, Instruments,
 Sutures, Wounds, etc
 chemotherapy in, 211
 elderly patient as surgical risk, analysis of
 322 operations performed on 244 patients
 60 years of age and over, 888
 more human attitudes in surgical practice,
 565
 new surgical instruments and devices, 406
 Orthopedic See Orthopedics
 plastic, in treatment of osteomyelitic war
 wounds, 206
 plastic, management of plastic maxillo-
 facial wounds in evacuation hospital, 99
 plastic, reconstruction of fingers, 390
 plastic, reconstruction of thumb and fin-
 gers, 388
- SURGICAL CLINICS**
 Complications of injection of thorotrast in
 carotid artery, 60
 Cystic emphysema of lungs, 328
- SURGICAL FORUM**
 Gastric resection for duodenal ulcer, 539
- Sutures**, reaction in surgical wounds to surgi-
 cal gut, silk and cotton sutures, 308
Swyer, A. J. Benign nonepithelial tumors
 of stomach, 529
- Talocalcaneal Joint** See Ankle
Tamponade See Heart
Tantalum, reconstruction of thumb and fin-
 gers, 388
Tarsus See Ankle, Foot
Teaching See Education, Medical
Teflon Tube See Apparatus
Temperature See Cold
Temporomandibular Joint See Jaws
Tendinitis See Tendons
Tendons, acute injuries of, 379
 acute suppurative tenosynovitis treated
 with systemic administration of penicillin,
 231
 and nerves, primary and secondary repair
 of, 381
 extensor digitorum communis, relationship
 to metacarpophalangeal joint, 373
 extensor, of finger, treatment of avulsion of,
 379
 extensor pollicis longus, rupture following
 Colles' fracture, 385
 flexor of finger, calcareous tendinitis of,
 383
 stenosing tenosynovitis and tendinitis, 383
 suppurative tenosynovitis in fingers, 377
 transplantation, in hand, 385
Tenosynovitis See Tendons
Teratoma, mediastinal, 797
Tetanus treated as respiratory problem, 478
Thigh See also Hip, Legs
 hemipelvectomy for malignant tumors of
 bony pelvis and upper part of thigh 867
 traumatic rupture of adductor muscles of,
 94
Thompson, H. L. Surgical treatment of
 carcinoma of esophagus and stomach 662
Thorax See also Heart, Lungs, Medias-
 tinum, Ribs, etc
 anesthesia in transthoracic surgery of ali-
 mentary tract, 679
 cystic emphysema of lungs, 328
 surgical treatment (transthoracic and
 abdominothoracic) of carcinoma of
 esophagus and stomach, 662

- Thorium dioxide, complications of injection of thorotrast in carotid artery, 60
- Thorotrast See Thorium dioxide
- Thrombasthenia See Purpura haemorrhagica
- Thrombin, use of human fibrin foam and thrombin solution as hemostatic agents in general surgery, 284
- Thromboanglitis Obliterans See Thrombophlebitis
- Thrombopenia See Purpura
- Thrombophlebitis See also Thrombosis
experimentally produced, effect of heparin and penicillin on, 163
histologic and chemical aspects of thrombus formation, 48
use of heparin and dicumarol in active treatment of thromboembolism, 603
- Thrombosis See also Embolism, Thrombophlebitis
extent of strangulation of small intestine compatible with life, experimental study, 312
histologic and chemical aspects of thrombus formation, 48
use of heparin and dicumarol in active treatment of thromboembolism, 603
- Thumb See Fingers and Toes
- Thymoma, mediastinal, 797
- Thyroid, carcinoma of, 875
- Tibia, use of barrel stave grafts in spinal fusion, 42
- Tibiotarsal Joint See Ankle
- Tissue, Adipose See Fat
reaction in surgical wounds to surgical gut, silk and cotton sutures, 308
- Toes See Fingers and Toes
- Tongue, hereditary syndrome comprising malformation of tongue and polydactylia, 126
- Torsion Spasm See Dystonia
- Torticollis, spasmodic, etiologic factors in, 100
- Tracheotomy, tetanus treated as respiratory problem, 478
- Traction See Apparatus
- Transfusion See Blood transfusion
- Transplantation See Bones, Skin, etc
- Trauma See also Accidents, Brain, Hand, Tendons, etc
antibiotics in surgery of, 228
early covering of traumatic deformities of foot and hand, 376
- Triquetrum See Wrist
- Trochanter See Femur
- Trochlea See Humerus
- Truss See Hernia, therapy
- Tuberculosis See also under names of diseases organs and regions, as Arthritis, Spine
in joints of extremities, differential diagnosis of, 554
of bones and joints, 546
of bones and joints, operative procedures in, 558
osteoarthritic multiple tuberculous fistulas with secondary infection, 557
osteoarthritic, penicillin therapy of secondary infected abscesses 556
osteoarthritic, suspected, 556
- Tumors See Adenoma, Cancer, Fibroma, Hematoma, Leiomyoma, Lipoma, Myoblastoma Neurofibroma Teratoma, and under names of organs and regions, as Back, Colon, Esophagus, Mediastinum, Pelvis, Stomach, Thigh, etc
- Turner V C Tetanus treated as respiratory problem, 478
- Uihlen, A Repair of defects in ethmoid and frontal sinuses resulting in cerebrospinal rhinorrhea, 623
- Ulcers, Peptic See Peptic Ulcer
- Ulna, splinting and rehabilitation, 387
- Umbilical Cord, hernia, and omphalocele (amniocoele) in newborn, 833
- Vanderhoof, E S Unfavorable reactions to oxidized cellulose (oxycel) in bed of gallbladder, "retained oxycel sponge syndrome," 182
- Vasomotor System See also Arteries, Blood pressure, Blood vessels, Capillaries, Veins
pathologic conditions involving vasomotor mechanism and Volkmann contracture 394
- Veins See also Blood vessels, Embolism, Thrombosis, Vasomotor System, etc
Coronary See Coronary Vessels
histologic and chemical aspects of thrombus formation, 48
jugular, effect of heparin and penicillin on experimentally produced thrombophlebitis 163
- Portal See Portal Vein
- Venae Cavae, nonsuture method for vascular anastomosis utilizing Murphy button principle, 504
use of portacaval anastomosis in portal cirrhosis, 590
- Venous Pressure See Blood pressure
- Vertebrae See Spine
- Viscera See also Abdomen, Pelvis, Thorax, etc
chronic ulcerative colitis with constitutional and visceral degenerative changes, 244
diseases, pain in lower part of back as chief or sole symptom of, 358
transposition, situs inversus totalis, statistical review of data on 76 cases with special reference to disease of biliary tract, 724
transposition, situs inversus with associated abnormalities, review of literature and report of 3 cases, 149
- Vital Statistics, elderly patients as surgical risk, analysis of 322 operations performed on 244 patients 60 years of age and over, 888
factors contributing to low mortality from appendectomy for acute appendicitis; 10 year study, 171
- Volkmann Contracture See Contracture, ischemic
- Volvulus See Intestines
- Vosseler, A J Ligation of carotid arteries for advanced malignant neoplasms of head and neck, 35
- War; See also Aviation and Aviators, Military Medicine, etc
general consideration of treatment of injuries of hand, 380
repair of bony defects associated with osteomyelitis, 207
skin grafting in treatment of osteomyelitic war wounds, 206
wounded chronic osteomyelitis in 231
wounds management of osteomyelitis secondary to, 200
- Weirhof's Disease See Purpura
- White, J W Amputations, apparatus and technic, 399
- Whitlow See Paronychia
- Wierman W H Suppurative disease of lungs, 819
- Williams J M Jr Multiple arterial emboli, 3 successful embolectomies in case of bacterial endocarditis, 25

- Wise, R. A.: Hemipelvectomy for malignant tumors of bony pelvis and upper part of thigh, 867
- Wood, W. Q.: Treatment of peptic ulceration by vascular ligation, 455
- Workmen's Compensation; disability evaluation for hand, 397
- Wounds: See also Military Medicine; War
aspiration of blood from pericardium in treatment of acute cardiac tamponade after injury; further experience, with report of cases, 463
chronic osteomyelitis in war wounded, 231
gunshot, chronic osteomyelitis as sequel to, 232
management of osteomyelitis secondary to war wounds, 200
management of plastic maxillofacial wounds in evacuation hospital, 99
repair of surface defects of upper extremities, 376
skin grafting in treatment of osteomyelitic war wounds, 206
surgical, reaction to surgical gut, silk and cotton sutures, 308
- Wounds—Continued
tuberculous, treatment in orthopedic cases, 557
use of penicillin therapy in conjunction with free bone grafting in infected areas, 204
- Wrist: See also Scaphoid Bone, Carpal
conditions involving elbow, forearm, wrist and hand, 372
congenital fusion of lunate and triquetrum, 117
dislocations of, 391
follow-up results of surgical treatment for nonunion of carpal scaphoid bone; report of 19 cases, 291
general consideration of treatment of injuries of hand, 380
splinting and rehabilitation, 387
- Wrist Drop; radial palsy, 383
- X-Rays: See Roentgen Rays
- Zimmermann, H. B.: More human attitudes in surgical practice; presidential address (Western Surgical Association), 565
- Zygodactyly: See Fingers and Toes, abnormalities

